ENVIRONMENTAL SERVICES
SPB05-894P-BB

1. PARTIES

THIS CONTRACT, is entered into by and between the State of Montana, Department of Administration, State Procurement Bureau, (hereinafter referred to as "the State"), whose address and phone number are Room 165 Mitchell Building, 125 North Roberts, PO Box 200135, Helena MT 59620-0135, (406) 444-2575 and **Tetra Tech, Inc.**, (hereinafter referred to as the "Contractor"), whose nine digit Federal ID Number, address and phone number are 95-4148514, 10306 Eaton Place, Suite 340, Fairfax VA 22030, and (703) 385-6000.

THE PARTIES AGREE AS FOLLOWS:

2. PURPOSE

The purpose of this term contract is to establish a list of Environmental Service Providers in several service areas. All qualified offerors will be assembled into a multiple contractor term contract for use by state agencies and other public procurement units. The State makes no guarantee of use by any agency-authorized access to this term contract. However, through data conveyed by the Montana Department of Environmental Quality, Montana Department of Natural Resources and Conservation, and Montana Fish, Wildlife and Parks, it is anticipated that this term contract should access approximately 2.5 million dollars or more annually.

3. EFFECTIVE DATE, DURATION, AND RENEWAL

3.1 Contract Term. This contract shall take effect upon execution of all signatures, and terminate on June 30, 2007, unless terminated earlier in accordance with the terms of this contract. (Mont. Code Ann. § 18-4-313.)

3.2 Contract Renewal. This contract may, upon mutual agreement between the parties and according to the terms of the existing contract, be renewed in one-year intervals, or any interval that is advantageous to the State, for a period not to exceed a total of four additional years. This renewal is dependent upon legislative appropriations.

3.3 Addition of Analytical Laboratory Contractor. Proposals will be accepted between April 1 and May 1 of each calendar year from current firms requesting review of their qualifications to perform Analytical Laboratory Services as originally requested under RFP SPB05-894P. The state will evaluate each proposal received in the exact manner in which the original proposals for other categories were evaluated. If proposal passes the requirements as evaluated to perform Analytical Lab Services, the state will update that firms term contract to include the Analytical Lab Services category contingent on said firm being in good standing otherwise.

4. NON-EXCLUSIVE CONTRACT

The intent of this contract is to provide state agencies with an expedited means of procuring supplies and/or services. This contract is for the convenience of state agencies and is considered by the State Procurement Bureau to be a "Non-exclusive" use contract. Therefore, agencies may obtain this product/service from sources other than the contract holder(s) as long as they comply with Title 18, MCA, and their delegation agreement. The State Procurement Bureau does not guarantee any usage.

5. COOPERATIVE PURCHASING

Under Montana law, public procurement units, as defined in section 18-4-401, MCA, have the option of cooperatively purchasing with the State of Montana. Public procurement units are defined as local or state public procurement units of this or any other state, including an agency of the United States, or a tribal procurement unit. Unless the bidder/offeror objects, in writing, to the State Procurement Bureau prior to the award of this contract, the prices, terms, and conditions of this contract will be offered to these public procurement units.

6. TERM CONTRACT REPORTING

Term contract holder(s) shall furnish annual reports of term contract usage. Each report shall contain complete information on all public procurement units utilizing this term contract. Minimum information required to be included in usage reports: name of the agency or governmental entity who contacted you regarding a potential project; project title; agency contact person; if the project was not successfully negotiated, state the reason; number and title of contracts received; total dollar amounts for contracts received; the names of your company personnel involved in the project; and project status as of usage report date. The report for this term contract will be due on July 20th of each year.

Reported volumes and dollar totals may be checked by the State Procurement Bureau against State records for verification. Failure to provide timely or accurate reports is justification for cancellation of the contract and/or justification for removal from consideration for award of contracts by the State.

7. COST/PRICE ADJUSTMENTS

7.1 Cost Increase by Mutual Agreement. After the initial term of the contract, each renewal term may be subject to a cost increase by mutual agreement. Contractor must provide written, verifiable justification for any cost adjustments they request during each renewal period. Contractor shall provide its cost adjustments in both written and electronic format.

7.2 Differing Site Conditions. If, during the term of this contract, circumstances or conditions are materially different than set out in the specifications, the Contractor may be entitled to an equitable adjustment in the contract price. The Contractor shall immediately cease work and notify, in writing, the State of any such conditions necessitating an adjustment as soon as they are suspected and prior to the changed conditions affecting the performance of this contract. Any adjustment shall be agreed upon in writing by both parties to the contract.

7.3 Cost/Price Adjustment. All requests for cost/price adjustment must be submitted between April 1st and April 30th along with written justification. Requests received after April 30th will not be considered unless written approval from the SPB Contracts Officer is given to submit at a later date. In no event will cost/price adjustments be allowed beyond May 15th. All requests that are approved will be incorporated by contract amendment and made effective July 1st of the next approved renewal period.

8. SERVICES AND/OR SUPPLIES

8.1 Service Categories. Contractor agrees to provide to the State the following services:

TMDL Targets. The TMDL program (within DEQ) will often need additional data in order to develop TMDL targets. Targets are quantitative water quality goals or “endpoints” that represent all the applicable narrative or numeric water quality standards. These targets, when achieved will represent full beneficial use support. This may require additional monitoring to determine reference condition when TMDL targets are based on narrative criteria or designated uses (water quality standards). Targets may be based on numeric water quality criteria, pollutant concentrations or loads, habitat or geomorphic measures, and/or biological criteria or populations. Targets are also used to determine the existing Water Quality Impairment Status (WQIS) of the streams on the 303(d) list. In most cases, the contractor will be required to write a report, which includes a recommendation and justification for one or more TMDL targets and also compare those targets to the existing conditions to determine WQIS. Communication with the State is crucial while deriving preliminary targets to ensure TMDL consistency across Montana.

TMDL Source Assessment/Delineation. The TMDL program (within DEQ) will often need additional data in order to link water quality impairments to their sources, or to allocate sources of pollutants. This may require data compilation, investigative monitoring and statistical analysis within a specified watershed, which can be used for source allocation, or the linkage of water quality impairments to causes and sources of impairment (e.g., sediment or land use practices). Quantitative source assessments may be conducted using field-based monitoring and/or interpretation and analysis of aerial photos, digital images, or GIS coverages depending upon impairment sources and available information. In most cases, contractors will be required to write a report that identifies what the major causes of impairment are and where the major sources of pollutants are located. DEQ will also need to have all pollution/pollutant sources quantified. The quantification of these loads will assist in both source load allocations and the total maximum daily loads. In addition, data collected during source assessments must be entered into an approved database structure or format and linkage to the National Hydrography Dataset (NHD) streams layer may be requested. The department may also request a cost/benefit analysis for implementing BMPs, which can be used for developing TMDL source allocations. Communication with the State is crucial while deriving assessing sources of pollutants to ensure TMDL consistency across Montana.

TMDL Load Allocations. The TMDL program (within DEQ) will often need additional data in order to develop load allocations in conjunction with the source assessment/delineation. Load allocations are the portion of a receiving water's loading capacity that is attributed to existing or future point or non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments. Allocation can be expressed as a percent reduction that results in a maximum allowable load or as performance-based, which demonstrates how BMPs will be applied and how they will reduce the current loads. Communication with the State is crucial while deriving preliminary load allocations to ensure TMDL consistency across Montana.

Total Maximum Daily Loads. The TMDL program (within DEQ) will often need additional data in order to develop Total Maximum Daily Loads (TMDLs). A TMDL is defined as the sum of the wasteload allocations to point sources, load allocations to non-point sources and natural background sources with a margin of safety considering seasonal variation. TMDLS can be expresses in terms of mass per time, toxicity, or other appropriate measures that relate to the State's Water Quality Standards. Communication with the State is crucial while deriving preliminary TMDLs to ensure consistency across Montana.

Geographic Information Systems (GIS) Services. The State, and in particular DEQ, will need assessments that characterize a watershed and identify and quantify all probable sources of pollutants. GIS maps will be required for every waterbody that is assessed. Thematic maps may include, but are not limited to: land ownership, land use, topography, hydrology, soils, precipitation, and/or endangered species distribution. In addition, DEQ may request that GIS applications be used to facilitate the interpretation and analysis of digital images and/or other georeferenced data.

Water Quality Modeling. The State, and in particular DEQ, uses contracted services in the development and/or application of watershed and water quality modeling tools and techniques in the development of TMDLs. Models may be used to assist in defining TMDL loading allocations, performing existing/potential conditions analysis, watershed scenario analysis, and/or standards attainment analysis. The types of models that may be employed include dynamic watershed loading models (i.e. SWAT, HSPF), water quality fate and transport models (i.e. QUAL2E, QUAL2K), stream temperature and/or shade models (i.e. SSTemp, HeatSource, Shadow), and multi-dimensional lake/reservoir models (i.e. CE QUAL W2). In addition, simpler modeling tools and techniques such as GIS-based Risk Assessment Modeling may be employed or developed based on project needs and resources. The DEQ may also seek assistance in the identification and/or development of simple modeling tools that may be implemented at the desktop that facilitate quick scenario applications. These tools should be able to focus on specific water quality issues such as sediment, nutrients, salinity, etc. and be tailored to the various (eco) regions across the state.

Statistical Analysis. The State may request that large data sets be statistically analyzed for determining trends or for making comparisons. This service area may include data compilation, organization, manipulation and analysis. These analyses may be used to validate environmental targets by comparing reference data to existing data. They may also be used to establish a relationship or linkage between indicators and targets, the estimated loads and how targets link to beneficial use support. Analyses should be appropriate for the type of data being analyzed. In many cases, the contractor will be responsible for determining and providing rationale for appropriate statistical analyses to address pre-formulated environmental hypotheses. Analyses must consider spatial and temporal variations. Analyses may range from providing simple descriptive statistics to reporting multifactor predictive analyses.

Communication/Education Services – Information Transfer & TMDL Technical Editing. Communication/education contractor specializing in information transfer would assist in the design, production and distribution of information for target audiences via TV, radio, or print media. These projects often require the conversion of complex water quality data into information the public can understand. Products include pamphlets, brochures, guidebooks, and videos; maintaining a webpage, writing press releases; set up public meetings, give interviews, make presentations at workshops and conferences and organize conferences and set up field trips. Offerors in this field may also specify their ability to provide Technical Editing of Natural Science documents, in particular Total Maximum Daily Load documents. Technical editing can include, but is not limited to proofreading for grammar and mathematical errors, document clarity, and linkage between different sections.

Preparation of Technical Manuals or Circulars. Regulatory programs require periodic preparation of technical materials to guide either public regulated entities or in-house staff in how to work through a regulatory requirement such as obtaining or writing a permit. These products require technical writing, document preparation, preparation of figures or tables, preparation and use of spreadsheets, research and assimilation of regulations, technical approaches to problem solving and explanation of approaches to prepare applications and/or actual permits.

8.2 Reuse of Documents. When the projects dictate a design or engineered approach, the State agrees that it will not apply the Contractor's designs to any other projects.

9. ENGINEERING ACCESS

All of the firms selected may need to have access to engineering services depending on the nature of the project. The contractor(s) will be expected to use their own best judgment as to whether engineering services are needed for a given project. However, traditional engineering methodologies are not the emphasis of this RFP. It is a violation of State Statute to practice engineering or land surveying without a license.

10. PROJECT SELECTION

10.1 Project Identification. The State will be responsible for identifying projects, contacting landowners and securing necessary permission/cooperation agreements, selecting a contractor, writing grant applications and approving project payments.

10.2 Hazardous Materials. The State will not initiate projects where it is known that hazardous materials are present. If there is an indication of a potential of hazardous materials, then the State will do testing prior to contacting the contractor. However, there is always the possibility of unforeseen problems resulting in the stoppage of a project.

10.3 Meetings. The selected contractor may be required to meet with State personnel at the project site to conduct a site evaluation, discuss project issues and begin the negotiation process on project feasibility, conceptual design and costs for each project.

10.4 Approach Expectations. In the case of restoration activities, the agency will identify the preferred techniques. The determination made by the State may define which contractor(s) are contacted for project initiation. The State is always open to new and innovative approaches that accomplish project goals.

11. SELECTING A CONTRACTOR

The State may select a term contract holder from the Environmental Services contract home page as provided under the state's website address http://www.discoveringmontana.com/doa/gsd/procurement/TermContracts/environservices/Default.asp, taking into consideration such things as the contractor's area of expertise, requirements and location of the project, the contractor's availability and access to resources necessary to efficiently and effectively complete the project, demonstrated excellent past performance on State and public projects, identified subcontractors and total project cost.

General. Ordering agencies shall use the procedures in this section when ordering services priced at hourly rates as established by each Term Contract (TC). The applicable service categories are identified in each TC along with the contractor's price lists.

Request for Quotation (RFQ) procedures. The ordering agency must provide an RFQ, which includes the statement of work and limited, but specific evaluation criteria (*e.g.*, experience and past performance), to TC contractors that offer services that will meet the agency's needs. The RFQ may be posted to the agency's state website to expedite responses.

Statement of Work (SOWs). All SOW's shall include at a minimum a detailed description of the work to be performed, location of work, period of performance, deliverable schedule, applicable performance standards and any special requirements (e.g., security clearances, travel, special knowledge).

(1) Ordering agency may select a contractor from the appropriate service category and directly negotiate a mutually acceptable project based on a sudden and unexpected happening or unforeseen occurrence or condition, which requires immediate action. (Exigency).

(2) Ordering agency may place orders at or below the $5,000 threshold with any TC contractor that can meet the agency's needs. The ordering agency should attempt to distribute orders among all service category contractors.

(3) For orders estimated to exceed $5,000 but less than $25,000.

   (i) The ordering agency shall develop a statement of work.
   (ii) The ordering agency shall provide the RFQ (including the statement of work and evaluation criteria) to at least three TC contractors that offer services that will meet the agency's needs.
   (iii) The ordering agency shall request that contractors submit firm-fixed prices to perform the services identified in the statement of work.

(4) For orders estimated to exceed $25,000. In addition to meeting the requirements of (3) above, the ordering agency shall:

   (i) Provide the RFQ (including the statement of work and the evaluation criteria) to a minimum of six service category TC contractors (if category has less than 6, all contractors will be offered an RFQ) with a 50% replacement factor for each subsequent request for quote in the same service category.

Evaluation. The ordering agency shall evaluate all responses received using the evaluation criteria provided in the RFQ to each TC contractor. The ordering agency is responsible for considering the level of effort and the mix of labor proposed to perform a specific task being ordered, and for determining that the total price is reasonable. The agency will place the order with the contractor that represents the best value. After award, ordering agencies will provide timely notification to unsuccessful TC contractors. If an unsuccessful TC contractor requests information on a task order award that was based on factors other than price alone, a brief explanation of the basis for the award decision shall be provided.

Minimum documentation. The ordering agency shall document:
(1) The TC contractors considered, noting the contractor from which the service was purchased.
(2) A description of the service purchased.
(3) The amount paid.
(4) The evaluation methodology used in selecting the contractor to receive the order.
(5) The rationale for making the selection.
(6) Determination of price fair and reasonableness.

Agency project task orders will be utilized to finalize the project. Only written addenda will be used for adjustments of the task orders and must be signed by both parties. All task orders must contain signatures from both parties and appropriate agency legal review as directed in their procurement policy.

The State will monitor contractor selection by using the information provided in the annual TC usage reports.

Contractor's who fail to respond to three RFQ opportunities within a one-year period between July 1st and June 30th may be removed from the qualified list of contractors.

12. CONTRACTOR RESPONSIBILITIES

12.1 Supervision and Implementation. The selected contractor for an individual project will be responsible for the supervision and implementation of the approach and will be responsible for oversight of work performed by all subcontractors. In most cases the contractor will provide and be responsible for all the necessary equipment, materials, supplies and personnel necessary for proper execution of the work. However, the State reserves the right to hire subcontractors (equipment and/or labor) if it will provide a cost savings to the State. The selected contractor will also be responsible for clean up of the sites if necessary and must have the sites inspected by the State immediately prior to completion.

12.2 On-Site Requirements. When a contractor is contacted by the State to discuss a project, the State and the contractor may visit the job site if deemed necessary by the Project Manager, to become familiar with conditions relating to the project and the labor requirements. The State will provide a detailed scope of work for the project and request the contractor supply the State with a response to project approach, cost, timeframe and any other information deemed necessary by the State to make a selection or complete a contract negotiation.

In the cases of Restoration or On-The-Ground Activities, the contractor shall adequately protect the work, adjacent property, and the public in all phases of the work. They shall be responsible for all damages or injury due to their action or neglect.

The contractor shall maintain access to all phases of the contract pending inspection by the State, the landowner, or their representative. All interim or final products funded by the contract will become the property of the State or Cooperative Purchaser upon payment for said products.

All work rejected as unsatisfactory shall be corrected prior to final inspection and acceptance. The contractor shall respond within seven calendar days after notice of observed defects has been given and shall proceed to immediately remedy these defects. Should the contractor fail to respond to the notice or not remedy the defects, the State may have the work corrected at the expense of the contractor.

12.3 Clean Up (when project tasks require). The contractor shall:

- Keep the premises free from debris and accumulation of waste;
- Clean up any oil or fuel spills;
- Keep machinery clean and free of weeds;
- Remove all construction equipment, tools and excess materials; and
- Perform finishing site preparation to limit the spread of noxious weeds before final payment by the State.

12.4 Applicable Laws. The contractor shall keep informed of, and shall comply with all applicable laws, ordinances, rules, regulations and orders of the City, County, State, Federal or public bodies having jurisdiction affecting any work to be done to provide the services required. The contractor shall provide all necessary safeguards for safety and protection, as set forth by the United States Department of Labor, Occupational Safety and Health Administration.

12.5 Cooperation. The contractor shall work closely with the States analytical consultants, (i.e. environmental laboratories and taxonomists) to develop the desired products.

12.6 Work Acceptance. The contractor is responsible for project oversight as needed. The State may also periodically provide personnel for administrative oversight from the initiation of the contract through project completion. All work will be inspected by the State or designated liaison prior to approval of any contract payments. All work rejected as unsatisfactory shall be corrected prior to final inspection and acceptance. Contractor shall respond within seven calendar days after notice of defects has been given by the State and proceed to immediately remedy all defects.

12.7 Records. The contractor will supply the State with documentation, when requested, of methods used throughout project implementation. Contractor will maintain records for themselves and all subcontractors of supplies, materials, equipment and labor hours expended.

12.8 Communication. Remoteness of project sites may necessitate that the contractor have some form of field communication such as a cellular phone. This communication is necessary to enable the State to respond to public concerns related to the project, accidents, inspections, or other project issues that require immediate feedback. In addition, the State or Cooperative Purchaser may require scheduled communication at agreed upon intervals. The communication schedule will be dependent upon the project circumstances and requirements of the contracting agency. In the case when a communication schedule is included in the Scope of Work, the schedule will commence when the contractor initiates the project.

12.9 Change of Staffing. Since qualifications of personnel were key in determining which offerors were selected to be on this TC, a written notification of any changes in key personnel must be made to the state agency, prior to entering into negotiations to perform any specific work scope. Contractor shall replace such employee(s) at its own expense with an employee of substantially equal abilities and qualifications without additional cost to the agency. If these staffing changes cause the contractor to no longer meet the qualifications stated herein, that firm will be removed from the service area of this TC. Failure to notify the state agency of staffing changes could result in the contractor being removed from the TC listing and possible suspension from bidding on other state projects.

12.10 Collaboration. The State encourages collaboration between contractors to increase the scope of services offered. In cases where the chosen contractor is not able to provide all services needed for the project, the State will expect the chosen contractor to contact other contractors on this list to negotiate subcontracts for these services before going elsewhere. Exceptions to this strategy will be evaluated on a case-by-case basis.

12.11 Subcontractors, Project Budget and Invoicing. All subcontractors to be used in any project must be approved by the authorized entity initiating the project. Project budgets will be negotiated for each individual project contract. However, all rates, terms and conditions set forth in this term contract will be applied to individual contracts. Subcontractor is defined as anyone other than the prime contractor having substantial direct involvement in a specific project.

The State reserves the right to choose the invoicing method from the following:

- Prime contractor's billing will include the subcontractors charges and payment will be made to the prime, or
- Prime and subcontractors will bill the State separately and the State will pay each directly.

13. CONSIDERATION/PAYMENT

13.1 Payment Schedule. In consideration for the services to be provided, the State shall pay according to the negotiated agreement for each project. Hourly rates and miscellaneous charges as provided in Attachment B shall apply.

13.2 Withholding of Payment. The State may withhold payments to the Contractor if the Contractor has not performed in accordance with this contract. Such withholding cannot be greater than the additional costs to the State caused by the lack of performance.

14. CONTRACTOR REGISTRATION

The Contractor will be registered with the Department of Labor and Industry under sections 39-9-201 and 39-9-204, MCA, *prior* to contract execution. The State cannot execute a contract for construction to a Contractor who is not registered. (Mont. Code Ann. § 39-9-401.)

Contractor Registration Number: 13678

15. CONTRACTOR WITHHOLDING

Section 15-50-206, MCA, requires the state agency or department for whom a public works construction contract over $5,000 is being performed, to withhold 1 percent of all payments and to transmit such monies to the Department of Revenue.

16. MONTANA PREVAILING WAGE REQUIREMENTS

Unless superseded by federal law, Montana law requires that contractors and subcontractors give preference to the employment of Montana residents for any public works contract in excess of $25,000 for construction or nonconstruction services in accordance with sections 18-2-401 through 18-2-432, MCA, and all administrative rules adopted pursuant thereto. Unless superseded by federal law, at least 50% of the workers of each contractor engaged in construction services must be performed by bona fide Montana residents. The Commissioner of the Montana Department of Labor and Industry has established the resident requirements in accordance with sections 18-2-403 and 18-2-409, MCA. Any and all questions concerning prevailing wage and Montana resident issues should be directed to the Montana Department of Labor and Industry.

In addition, unless superseded by federal law, all employees working on a public works contract shall be paid prevailing wage rates in accordance with sections 18-2-401 through 18-2-432, MCA, and all administrative rules adopted pursuant thereto. Montana law requires that all public works contracts, as defined in section 18-2-401, MCA, in which the total cost of the contract is in excess of $25,000, contain a provision stating for each job classification the standard prevailing wage rate, including fringe benefits, travel, per diem, and zone pay that the contractors, subcontractors, and employers shall pay during the public works contract.

Furthermore, section 18-2-406, MCA, requires that all contractors, subcontractors, and employers who are performing work or providing services under a public works contract post in a prominent and accessible site on the project staging area or work area, no later than the first day of work and continuing for the entire duration of the contract, a legible statement of all wages and fringe benefits to be paid to the employees in compliance with section 18-2-423, MCA. Section 18-2-423, MCA, requires that employees receiving an hourly wage must be paid on a weekly basis.

Each contractor, subcontractor, and employer must maintain payroll records in a manner readily capable of being certified for submission under section 18-2-423, MCA, for not less than three years after the contractor's, subcontractor's, or employer's completion of work on the public works contract.

The nature of the work performed or services provided under this contract meets the statutory definition of a "public works contract" under section 18-2-401(11)(a), MCA, and falls under the category of Heavy Construction and Nonconstruction services. The booklets containing Montana's 2003 Rates for Heavy Construction and Nonconstruction Services are attached.

The most current Montana Prevailing Wage Booklet will automatically be incorporated at time of renewal. It is the contractor's responsibility to ensure they are using the most current prevailing wages during performance of its covered work.

17. ACCESS AND RETENTION OF RECORDS

17.1 Access to Records. The Contractor agrees to provide the State, Legislative Auditor or their authorized agents access to any records necessary to determine contract compliance. (Mont. Code Ann. § 18-1-118.)

17.2 Retention Period. The Contractor agrees to create and retain records supporting the environmental services for a period of three years after either the completion date of this contract or the conclusion of any claim, litigation or exception relating to this contract taken by the State of Montana or a third party.

18. ASSIGNMENT, TRANSFER AND SUBCONTRACTING

The Contractor shall not assign, transfer or subcontract any portion of this contract without the express written consent of the State. (Mont. Code Ann. § 18-4-141.) The Contractor shall be responsible to the State for the acts and omissions of all subcontractors or agents and of persons directly or indirectly employed by such subcontractors, and for the acts and omissions of persons employed directly by the Contractor. No contractual relationships exist between any subcontractor and the State.

19. HOLD HARMLESS/INDEMNIFICATION

The Contractor agrees to protect, defend, and save the State, its elected and appointed officials, agents, and employees, while acting within the scope of their duties as such, harmless from and against all claims, demands, causes of action of any kind or character, including the cost of defense thereof, arising in favor of the Contractor's employees or third parties on account of bodily or personal injuries, death, or damage to property arising out of services performed or omissions of services or in any way resulting from the acts or omissions of the Contractor and/or its agents, employees, representatives, assigns, subcontractors, except the sole negligence of the State, under this agreement.

20. REQUIRED INSURANCE

20.1 General Requirements. The Contractor shall maintain for the duration of the contract, at its cost and expense, insurance against claims for injuries to persons or damages to property, including contractual liability, which may arise from or in connection with the performance of the work by the Contractor, agents, employees, representatives, assigns, or subcontractors. This insurance shall cover such claims as may be caused by any negligent act or omission.

20.2 Primary Insurance. The Contractor's insurance coverage shall be primary insurance as respect to the State, its officers, officials, employees, and volunteers and shall apply separately to each project or location. Any insurance or self-insurance maintained by the State, its officers, officials, employees or volunteers shall be excess of the Contractor's insurance and shall not contribute with it.

20.3 Specific Requirements for Commercial General Liability. The Contractor shall purchase and maintain occurrence coverage with combined single limits for bodily injury, personal injury, and property damage of $1,000,000 per occurrence and $2,000,000 aggregate per year to cover such claims as may be caused by any act, omission, or negligence of the Contractor or its officers, agents, representatives, assigns or subcontractors.

20.4 Additional Insured Status. The State, its officers, officials, employees, and volunteers are to be covered and listed as additional insureds; for liability arising out of activities performed by or on behalf of the Contractor, including the insured's general supervision of the Contractor; products and completed operations; premises owned, leased, occupied, or used.

20.5 Specific Requirements for Automobile Liability. The Contractor shall purchase and maintain coverage with split limits of $500,000 per person (personal injury), $1,000,000 per accident occurrence (personal injury), and $100,000 per accident occurrence (property damage), OR combined single limits of $1,000,000 per occurrence to cover such claims as may be caused by any act, omission, or negligence of the contractor or its officers, agents, representatives, assigns or subcontractors.

20.6 Additional Insured Status. The State, its officers, officials, employees, and volunteers are to be covered and listed as additional insureds for automobiles leased, hired, or borrowed by the Contractor.

20.7 Specific Requirements for Professional Liability. The Contractor shall purchase and maintain occurrence coverage with combined single limits for each wrongful act of $1,000,000 per occurrence and $2,000,000 aggregate per year to cover such claims as may be caused by any act, omission, negligence of the Contractor or its officers, agents, representatives, assigns or subcontractors. Note: if "occurrence" coverage is unavailable or cost prohibitive, the Contractor may provide "claims made" coverage provided the following conditions are met: (1) the commencement date of the contract must not fall outside the effective date of insurance coverage and it will be the retroactive date for insurance coverage in future years; and (2) the claims made policy must have a three year tail for claims that are made (filed) after the cancellation or expiration date of the policy.

20.8 Deductibles and Self-Insured Retentions. Any deductible or self-insured retention must be declared to and approved by the state agency. At the request of the agency either: (1) the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects the State, its officers, officials, employees, or volunteers; or (2) at the expense of the Contractor, the Contractor shall procure a bond guaranteeing payment of losses and related investigations, claims administration, and defense expenses.

20.9 Certificate of Insurance/Endorsements. A certificate of insurance from an insurer with a Best's rating of no less than A- indicating compliance with the required coverages, has been received by the State Procurement Bureau, PO Box 200135, Helena MT 59620-0135. The Contractor must notify the State immediately, of any material change in insurance coverage, such as changes in limits, coverages, change in status of policy, etc. The State reserves the right to require complete copies of insurance policies at all times.

21. COMPLIANCE WITH THE WORKERS' COMPENSATION ACT

Contractors are required to comply with the provisions of the Montana Workers' Compensation Act while performing work for the State of Montana in accordance with sections 39-71-120, 39-71-401, and 39-71-405, MCA. Proof of compliance must be in the form of workers' compensation insurance, an independent contractor's exemption, or documentation of corporate officer status. Neither the contractor nor its employees are employees of the State. This insurance/exemption must be valid for the entire term of the contract. A renewal document must be sent to the State Procurement Bureau, PO Box 200135, Helena MT 59620-0135, upon expiration.

22. COMPLIANCE WITH LAWS

The Contractor must, in performance of work under this contract, fully comply with all applicable federal, state, or local laws, rules and regulations, including the Montana Human Rights Act, the Civil Rights Act of 1964, the Age Discrimination Act of 1975, the Americans with Disabilities Act of 1990, and Section 504 of the Rehabilitation Act of 1973. Any subletting or subcontracting by the Contractor subjects subcontractors to the same provision. In accordance with section 49-3-207, MCA, the Contractor agrees that the hiring of persons to perform the contract will be made on the basis of merit and qualifications and there will be no discrimination based upon race, color, religion, creed, political ideas, sex, age, marital status, physical or mental disability, or national origin by the persons performing the contract.

23. INTELLECTUAL PROPERTY

All patent and other legal rights in or to inventions created in whole or in part under this contract must be available to the State for royalty-free and nonexclusive licensing. Both parties shall have a royalty-free, nonexclusive, and irrevocable right to reproduce, publish or otherwise use and authorize others to use, copyrightable property created under this contract.

24. PATENT AND COPYRIGHT PROTECTION

24.1 Third Party Claim. In the event of any claim by any third party against the State that the products furnished under this contract infringe upon or violate any patent or copyright, the State shall promptly notify Contractor. Contractor shall defend such claim, in the State's name or its own name, as appropriate, but at Contractor's expense. Contractor will indemnify the State against all costs, damages and attorney's fees that accrue as a result of such claim. If the State reasonably concludes that its interests are not being properly protected, or if principles of governmental or public law are involved, it may enter any action.

24.2 Product Subject of Claim. If any product furnished is likely to or does become the subject of a claim of infringement of a patent or copyright, then Contractor may, at its option, procure for the State the right to continue using the alleged infringing product, or modify the product so that it becomes non-infringing. If none of the above options can be accomplished, or if the use of such product by the State shall be prevented by injunction, the State will determine if the Contract has been breached.

25. CONTRACT TERMINATION

25.1 Termination for Cause. The State may, by written notice to the Contractor, terminate this contract in whole or in part at any time the Contractor fails to perform this contract.

25.2 Reduction of Funding. The State, at its sole discretion, may terminate or reduce the scope of this contract if available funding is reduced for any reason. (See Mont. Code Ann. § 18-4-313(3).)

26. STATE PERSONNEL

26.1 State Contract Manager. The State Contract Manager identified below is the State's single point of contact and will perform all contract management pursuant to section 2-17-512, MCA, on behalf of the State. Written notices, requests, complaints or any other issues regarding the contract should be directed to the State Contract Manager.

The State Contract Manager for this contract is:

Robert Oliver, Contracts Officer
Room 165 Mitchell Building
125 North Roberts
PO Box 200135
Helena MT 59620-0135
Telephone #: (406) 444-0110
Fax #: (406) 444-2529
E-mail: roliver@mt.gov

26.2 State Project Manager. Each using State agency or Cooperative Purchaser will identify a Project Manager in the project task order. The Project Manager will manage the day-to-day project activities on behalf of the State/Cooperative Purchaser.

27. CONTRACTOR PERSONNEL

27.1 Change Of Staffing. Since qualifications of personnel was key in determining which offerors were selected to be on this term contract list, a written notification to the State Procurement Bureau of any changes of key personnel must be made within two weeks of the change. These change notifications will be completed upon the departure or hiring of key personnel who are professional employees critical to awarded service areas. If these staffing changes cause the firm to no longer meet the qualifications stated herein, that firm will be removed from the service area of this term contract. Failure to notify the State Procurement Bureau of staffing changes could result in the contractor being removed from the term contract listing and possible suspension from bidding on other State projects.

27.2 Contractor Contract Manager. The Contractor Contract Manager identified below will be the single point of contact to the State Contract Manager and will assume responsibility for the coordination of all contract issues under this contract. The Contractor Contract Manager will meet with the State Contract Manager and/or others necessary to resolve any conflicts, disagreements, or other contract issues.

The Contractor Contract Manager for this contract is:

Allison Barker
10306 Eaton Place, Suite 340
Fairfax, VA 22030
Telephone #: (703) 385-6000
Fax #: (703) 385-6007
E-mail: allison.barker@tetratech-ffx.com

27.3 Contractor Project Manager. The Contractor Project Manager identified below will manage the day-to-day project activities on behalf of the Contractor:

The Contractor Project Manager for this contract is:

Kevin Kratt
10306 Eaton Place, Suite 340
Fairfax, VA 22030
Telephone #: (216) 861-2950 x 101
Fax #: (216) 861-2960
E-mail: kevin.kratt@tetratech-ffx.com

28. MEETINGS

The Contractor is required to meet with the State's personnel, or designated representatives, to resolve technical or contractual problems that may occur during the term of the contract or to discuss the progress made by Contractor and the State in the performance of their respective obligations, at no additional cost to the State. Meetings will occur as problems arise and will be coordinated by the State. The Contractor will be given a minimum of three full working days notice of meeting date, time, and location. Face-to-face meetings are desired. However, at the Contractor's option and expense, a conference call meeting may be substituted. Consistent failure to participate in problem resolution meetings two consecutive missed or rescheduled meetings, or to make a good faith effort to resolve problems, may result in termination of the contract.

29. CONTRACTOR PERFORMANCE ASSESSMENTS

The State may do assessments of the Contractor's performance. This contract may be terminated for one or more poor performance assessments. Contractors will have the opportunity to respond to poor performance assessments. The State will make any final decision to terminate this contract based on the assessment and any related information, the Contractor's response and the severity of any negative performance assessment. The Contractor will be notified with a justification of contract termination. Performance assessments may be considered in future solicitations.

30. TRANSITION ASSISTANCE

If this contract is not renewed at the end of this term, or is terminated prior to the completion of a project, or if the work on a project is terminated, for any reason, the Contractor must provide for a reasonable period of time after the expiration or termination of this project or contract, all reasonable transition assistance requested by the State, to allow for the expired or terminated portion of the services to continue without interruption or adverse effect, and to facilitate the orderly transfer of such services to the State or its designees. Such transition assistance will be deemed by the parties to be governed by the terms and conditions of this contract, except for those terms or conditions that do not reasonably apply to such transition assistance. The State shall pay the Contractor for any resources utilized in performing such transition assistance at the most current rates provided by the contract. If there are no established contract rates, then the rate shall be mutually agreed upon. If the State terminates a project or this contract for cause, then the State will be entitled to offset the cost of paying the Contractor for the additional resources the Contractor utilized in providing transition assistance with any damages the State may have otherwise accrued as a result of said termination.

31. CHOICE OF LAW AND VENUE

This contract is governed by the laws of Montana. The parties agree that any litigation concerning this bid, proposal or subsequent contract must be brought in the First Judicial District in and for the County of Lewis and Clark, State of Montana and each party shall pay its own costs and attorney fees. (See Mont. Code Ann. § 18-1-401.)

32. SCOPE, AMENDMENT AND INTERPRETATION

32.1 Contract. This contract consists of 12 numbered pages, any Attachments as required, RFP # SPB05-894P**,** as amended and the Contractor's RFP response as amended. In the case of dispute or ambiguity about the minimum levels of performance by the Contractor the order of precedence of document interpretation is in the same order.

32.2 Entire Agreement. These documents contain the entire agreement of the parties. Any enlargement, alteration or modification requires a written amendment signed by both parties.

33. EXECUTION

The parties through their authorized agents have executed this contract on the dates set out below.

DEPARTMENT OF ADMINISTRATION
STATE PROCUREMENT BUREAU
PO BOX 200135
HELENA MT 59620-0135

BY:______________________________________
Penny Moon, Contracts Officer

BY:______________________________________
(Signature)

DATE:____________________________________

TETRA TECH, INC.
10306 EATON PLACE, SUITE 340
FAIRFAX VA 22030
FEDERAL ID # 95-4148514

BY:______________________________________
(Name/Title)

BY:______________________________________
(Signature)

DATE:____________________________________

ATTACHMENT A
CONTRACTOR'S RESPONSE

1.0 INTRODUCTION

1.1 Our Company

Tetra Tech, Inc. is a leading provider of specialized environmental management consulting and technical services and has developed innovative, successful, and cost-effective solutions to complex environmental problems for public and private clients since 1966. Our success derives from providing unmatched technical skills in a wide range of disciplines and committing to open, honest communication about project performance with our clients, which fosters partnerships that enable us to meet fast-track schedules and stay within budget. As a company, we are quite proud of our role as the national leader in high-quality environment support for numerous state, federal, and local agencies. Our vision for growth and diversification to meet clients' needs has been another key to our success. As environmental policies and regulations have changed the ways our clients do business, we have hired national experts and acquired firms that are knowledgeable in those areas and has put their skills to work. The result is that today, as a publicly owned company, we have 150 offices worldwide with approximately 7,000 employees in 70 engineering and scientific disciplines.

1.2 Corporate Water Resources and TMDL Center

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including TMDLs, to state, local, and federal agencies. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and nearly all 50 states. Because of our national prominence, we have been formally acknowledged as Tt's corporate leader in water resources and TMDLs. In addition to the staff located in Fairfax, we have located support offices in strategic locations throughout the US and each of these offices is fully-supported on all projects by technical, contract, and administrative staff located in Fairfax and have full access to our resources. The TMDL, assessment, and watershed projects underway or completed by our staff cover the full range of pollutants, sources, and waterbody types, providing us with the expertise required to reliably provide TMDL-related technical support with utmost efficiency.

As requested, Table 1-1 summarizes the Service Categories for which the Tt Water Resources and TMDL Center is submitting. Our Tt EM Inc. and Tt Maxim office will also be submitting a proposal with qualifications focused on providing support to service categories that complement those identified below. These offices are emphasizing their local strength (150 staff located within the state) in monitoring, logistics, and GIS-related support.

2.0 INFORMATIONAL REQUIREMENTS

The following sections of our proposal address the RFP-requested informational requirements for each service category for which we are submitting:

- TMDL Targets
- TMDL Source Assessment/Delineation
- TMDL Load Allocations
- Total Maximum Daily Loads
- Geographic Information Systems (GIS) Services
- Water Quality Modeling
- Statistical Analysis
- Communication/Educational Services – Information Transfer & TMDL Technical Editing
- Preparation of Technical Manuals or Circulars

We begin each section by providing a list of client references (including short project descriptions) for which we have performed similar work. We then describe how long we have been performing these types of services and highlight the experience of the proposed key personnel. An example work plan is also presented that provides more detail regarding how we accomplished one of the projects described in the References section. Finally, we present a summary table with the qualifications of our proposed staff.

2.1 Service Category 3.5.4: TMDL Targets

Tt understands that in many respects the TMDL Program revolves around establishing appropriate water quality standards. When developing TMDLs, site-specific targets for pollutants without numeric criteria must be identified both to make correct impairment status decisions and to identify appropriate reduction strategies. The following sections describe our previous experience and qualifications in identifying appropriate targets.

2.1.1 References

We feel that one of the best indicators of our ability to deliver quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references. Please note that Tt has completed more than 2,000 TMDLs nationwide over the past ten years and therefore the table below represents only a very small subset of our work in this area. Multiple TMDL projects have been completed for most of the references in the table shown below.

Table 2-1. Summary of references for Service Category 3.5.4: TMDL Targets.

Reference Information	Description of Service
Ron Steg USEPA Region 8 Montana Operations Office Helena, MT (406) 457-5024	For USEPA Region 8, we developed a suite of targets and supplemental indicators to evaluate sediment beneficial use conditions in the Dearborn River, Montana. The targets and supplemental indicators included percent surface fines, macroinvertebrate populations, total suspended solids, riparian habitat conditions, and presence or absence of anthropogenic sources. We worked in close collaboration with Montana biological experts such as Wease Bollman and Loren Bahls to understand and apply the biological data appropriately. We also spent several weeks in the watershed taking geomorphologic measurements to determine appropriate channel metric targets. These targets and supplemental indicators were developed in conjunction with DEQ's recent Sediment Targets Workshop (held April 28/29, 2004 in Missoula) and were used to finalize impairment decisions and develop draft TMDLs. *Dates: March 2003 to Present*
Dave Montali TMDL Coordinator West Virginia Department of Environmental Protection Charleston, West Virginia (304) 558-2837	Tt staff are currently supporting the development of biological TMDLs for impaired streams in the Upper Ohio, Upper Kanawha, Lower Kanawha, Coal River, and North Branch Potomac watersheds in West Virginia. Many of these streams were listed as impaired based solely on biomonitoring data collected by West Virginia DEP; therefore, stressor identification principles and techniques were used to identify the primary cause(s) of biological impairment in each stream. Stressor identification involved the analysis of available water quality, habitat, physical, and biological data to determine the likely impairment cause(s). Statistical techniques were used to examine stressor-biological response relationships, including the development of novel diagnostic tools that utilize biological data to help identify and rank potential benthic community stressors. A reference watershed approach was used to define regional and site-specific TMDL endpoints for identified stressors (pollutants). Presentations of this approach and its applicability were made at various technical conferences, including AWRA 2002 (Philadelphia, PA), WEF Watersheds 2002 (Fort Lauderdale, FL), SETAC 2001 (Baltimore, MD), and the Mid-Atlantic Water Pollution Biology Workshop 2001/2003 (Cacapon, WVa). *Dates: October 2002 to Present*

Harry Judd Utah DEQ Division of Water Quality Salt Lake City, UT (801) 538-6146	For Utah DEQ, we supported the identification of possible endpoints for nutrient impairments in East Canyon Reservoir. The state requested our support for identifying endpoints that would be protective of the reservoir and that were achievable using best available technology. The analysis consisted of a comprehensive review of available studies to determine the state-of-the-science for advanced treatment technologies, review of existing permits to determine what had been accepted in the past, and a review of numerous TMDLs and other water quality studies. We provided recommendations that were used to formulate the TMDL and subsequent permits and load allocations. *Dates: March 1999 to April 2000*
Dave Smith USEPA Region 9 TMDL Team Leader San Francisco, CA (415) 972-3416	For EPA Region 9, our staff has supported the development of over 10 sediment TMDLs for watersheds in northern CA. Only narrative criteria exist for sediment. Tt staff worked with EPA and the state to conduct reviews of available data from pre- and post-harvest sites and developed an inventory of possible reference sites. This process was complicated by the need to address the geologic instability associated with the region and the relatively large natural erosion and mass wasting rates. A final suite of indicators was developed and targets were established for the TMDL. *Dates: October 1995 to Present*
Ruth Watkins Tri-State Water Quality Council Sandpoint, ID (208) 265-9092	For Pend Oreille Lake, Idaho we developed innovative target values for the Near Shore TMDL. These target values were developed consistent with near shore monitoring data, shoreline land use types, and the lake-wide TMDL targets. A long-term average target value and short-term action targets were defined for total phosphorus in the near shore area, resulting in guidelines for future monitoring and evaluation of the TMDL. *Dates: August 2001 to February 2002*
Jean Chruscicki USEPA Region 5 Chicago, IL 60604 (312) 353-1435	For EPA Region 5 we developed sediment and nutrient TMDLs for the Wabash River watershed, Ohio. Since Ohio does not have numeric criteria for nutrients or sediments, site-specific TMDL targets had to be derived. Nutrient (TP and nitrate+nitrite) targets were derived based on guidance published by OEPA and sediment targets were based on a statistical analysis of available data within the watershed. *Dates: April 2003 to March 2004*
Peter Krottje California Regional Water Quality Control Board San Francisco Bay Region (510) 622-2382	For the state of California Tt developed a process for developing statewide nutrient criteria that could also be used to develop TMDLs. As a first and critical step, we proposed that nutrient criteria not be defined solely in terms of the concentrations of various nitrogen and phosphorus species, but also include consideration of primary biological responses to nutrients. Further, the development of chemical concentration criteria should be closely linked to the evaluation of biological responses. To evaluate various aspects of this issue we developed a series of “white papers” on (i) a risk-based approach to nutrient criteria, including generalized conceptual models for nutrient impacts on beneficial uses, (ii) review of peer-reviewed scientific literature since the publication of the US EPA nutrient-criteria guidance documents, (iii) review of recently completed nutrient TMDLs in the Western US, (iv) methods by which to make independent estimates of nutrient loads from various sources, including WWTPs, septic systems, animal feeding operations, (v) use of the SWAT model to evaluate watershed loads, including loads from the atmosphere and groundwater, (vi) use of HSPF/LSPC to estimate existing and allowable loads, (vii) advantages and disadvantages of using load duration curves to estimate existing and allowable loads, and (viii) discussion of other models that can be used for calculating nutrient loads from watersheds. *Dates: January 1999 to Present*
Mimi Dannel USEPA Headquarters Washington, DC (202) 564-9944	Tt developed the *Protocol for Developing Sediment TMDLs* (EPA 841-B-99-004) and the *Protocol for Developing Nutrient TMDLs* (EPA 841-B-99-007) to provide an organizational framework as well as technical background for establishing TMDLs for the most frequent causes of water quality impairment. The protocols provide programmatic and technical background and guidance on all aspects of the TMDL development process as related to the pollutants of concern, including characterization of the impairment; establishment of water quality endpoints and targets; identification and characterization of sources; linkage of source loadings to in stream water quality response and water quality targets; allocation of loading capacity; implementation of TMDL allocations; and post-implementation monitoring. *Dates: January 1997 to January 2001.*

Kathryn Hernandez TMDL Specialist USEPA Region 8 Denver, CO (303) 312-6101	EPA is requiring states and regions to develop numeric nutrient criteria to manage excessive levels of nutrients identified in surface waters of the United States. In order to develop nutrient criteria, EPA regions and states have recognized the need to identify reliable reference conditions with respect to nutrient concentrations, and to determine early stages of biological impairment from nutrient enrichment. EPA Region 8 assigned Tt to design, coordinate, and analyze a monitoring and experimental project to identify reference nutrient conditions, and determine threshold biological effects of nutrient enrichment in streams of the glaciated plains of Montana and North Dakota. Tt facilitated a workshop of local experts and state and EPA participants to develop the sampling and experimental design. Tt provided statistical guidance on project design including screening for site selection and guidance on statistical independence and power. Tt developed a screening methodology using a land use index of the relative alteration of natural land cover (natural vegetation to intensive cropland). Candidate sites were selected to span the gradient from natural to most heavily altered, so that water quality and biological response of streams to agricultural nutrient inputs could be examined. Tt prepared the Quality Assurance Project Plan (QAPP). Tt analyzed and interpreted data from the first year of the pilot study, and recommended modifications to the study plan. Tt is currently analyzing the final data set from the project to facilitate the development of regional-specific nutrient criteria. *Dates: April 2001 to Present.*
Jayne Carlin TMDL Specialist USEPA Region 10 Seattle, WA (206) 553-8512	Several water bodies within the Coeur d'Alene reservation are included on Idaho's 303(d) list for nutrients and sediments. Tt performed extensive data analysis to identify TSS and turbidity values representative of background, target and existing conditions for a variety of flow ranges. Using identified targets and an evaluation of the distribution of flow, Tt calculated loading capacities and necessary load reductions for the stream under different flow conditions. Tt is also developing TMDLs for nutrients and sediments for Fighting Creek, using Generalized Watershed Loading Function to simulate watershed loadings. Future TMDLs include sediment and nutrient TMDLs for Black Lake and Willow Creek*. Dates: June 2003 to Present*

2.1.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including TMDLs, to state, local, and federal agencies. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and 40 states. Many of these TMDLs have required the identification of TMDL targets because they were developed for pollutants without numeric criteria (e.g., sediment and nutrients). Our experience dates back to the opening of the Center for Water Resources office in 1976 but has significantly increased during the past 10 years as the TMDL program has expanded nationwide. All work has been performed under the company name Tetra Tech, Inc. This section provides biosketches for the key personnel who will provide primary support in this service category. Many of our other TMDL specialists also have experience in the identification of TMDL targets. Full resumes of all personnel are provided in Appendix A.

Jason Gildea (Project Manager)
Mr. Gildea is an environmental scientist with expertise in water resources, data analysis, and GIS. He has experience using a holistic approach to watershed management that includes applying knowledge of surface water, groundwater, geology, soils, and land use. He has used this approach to support TMDL development for multiple projects throughout the United States. Recent projects include the preparation of TMDLs for the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana. Mr. Gildea has also be extensively involved in the development of sediment TMDLs for the Flathead Headwaters. Mr. Gildea has over five years of experience with data management, GIS software, and electronic datasets. He has performed statistical analyses of water quality data using statistical software, GIS, and remote sensing. While working for the US Geological Survey, he participated in a surface and groundwater sampling program and gained experience in working with USGS water quality data and databases. He is proficient in MS Office, ERDAS Imagine, Arc Info/ Arc View (Unix + PC), Idrisi, and Adobe Photoshop.

Andrew Parker
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Clint Boschen
Mr. Boschen has more than seven years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He has supported Clean Water Act programs at the state and national level and is currently involved in TMDL development projects and biological assessment studies throughout the country. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. He routinely conducts watershed studies focusing on the assessment of biological condition in relation to pollutant levels and anthropogenic impacts. Mr. Boschen has experience in planning and conducting field monitoring studies, watershed characterization and modeling, wetland and stream corridor assessments, and water quality planning activities. His academic and research experience is in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Shad Bowman
Mr. Bowman has over 7 years of experience with various water resources issues involving Total Maximum Daily Loads (TMDLs), surface water quality standards, drinking water, and ecological studies. Mr. Bowman is familiar with ecosystems of the western United States, and has participated in several projects for TMDLS, water quality standards, restoration projects, outreach, and policy development in regards to differing ecosystems. Mr. Bowman has served as a project manager for over 110 TMDLs that addressed various contaminants, stream reaches, and conditions. He has been directly involved in the development of over 200 total TMDLs. He has been involved in, and responsible for, all phases of the TMDL development process, from water quality standards review and development, to impairment assessments and determinations to delisting and TMDL creation, and implementation and restoration planning. In addition to TMDLs, Mr. Bowman has been involved in the development of surface water quality standards development, rule and policy development activities, sampling plan development, 303(d) and 305(b) assessments, data analysis, database development, and public meeting facilitation and outreach activities. Mr. Bowman has designed developed and presented several workshops, trainings, and presentations dealing with TMDLs, Implementation, Source Assessments, and Stream Restoration.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher’s current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has

conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

John Craig
Mr. Craig is a water resources specialist with more than 14 years of experience evaluating watershed and water quality problems and providing support for federal, state, and local policy issues. His areas of expertise include watershed management, Total Maximum Daily Load (TMDL) development and training; water quality assessment; and risk assessment. Currently projects include management of a nutrient criteria pilot study in Montana and North Dakota; management of a nutrient assessment for the watersheds of Lake Elsinore, CA; management and technical support for the development of nutrient and pathogen TMDLs for the Los Angeles River; and management and development of a watershed management plan and TMDL for Pineview Reservoir, Utah. Mr. Craig currently serves as the director of Tt's Fairfax Water Resources department and has been providing ongoing management and technical support for local, state, and federal water programs in the south and west.

Jeroen Gerritsen
Dr. Gerritsen has more than 25 years of experience in aquatic environmental sciences, including basic and applied research, teaching, environmental assessment, and project management. His technical abilities include statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, stream ecology, and plant-nutrient relationships. He has directed multidisciplinary investigations and has contributed technical expertise to impact assessment and regulatory review, effects of acidic deposition, and design and analysis of environmental monitoring programs. He has broad field experience in lakes of North America and Europe; in streams, wetlands, and estuaries of the continental United States; and in the North Atlantic ocean.

Kirk Gregory
Dr. Gregory is an environmental scientist with more than 9 years of experience in hydrologic modeling, geographic information systems (GIS), and remote sensing technologies for urban and agricultural watershed assessment and management. He uses hydrologic models coupled with GIS to assess the impacts of land use change on water quantity and quality. He also uses GIS-based models to examine sediment erosion processes from cultivation and construction activities. He has demonstrated an ability to deliver innovative solutions that encompass local, state, and federal water resource objectives and goals.

Nick Jokay
Mr. Nick Jokay, a recent addition to the Tt team, is a geomorphologist with experience conducting field assessments for the USDA-ARS National Sedimentation Laboratory. This work has covered 25 states focusing on streambeds and streambanks as potential clean sediment pollutant sources for TMDL studies. He has set up flow/duration curves, effective discharge curves, and pollutant/discharge rating curves to estimate pollutant loadings. Mr. Jokay is presently developing a field protocol for assessing stream channel stability as part of a total TMDL protocol for the state of Tennessee that includes developing a metals TMDL.

Jessica Koenig
Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Kevin Kratt
Mr. Kratt has more than eight years of experience in water resources analysis for point and nonpoint source pollution in both urban and agricultural areas. This experience includes watershed modeling, water quality analysis, selection of water quality targets, and evaluation of best management practices (BMPs). He has also been extensively involved in the national and local evaluation of TMDL development activities and in various point and nonpoint source policy issues. Mr. Kratt has been supporting EPA and various state agencies on the TMDL and related programs since 1995. He has provided technical and programmatic support to all phases of the TMDL program, from guidance development, technical reviews, and TMDL development, to national training and facilitation. His support has included review of numerous TMDLs, technical oversight for more than a hundred TMDL development projects throughout the United States, development of new TMDL course materials, development of the first TMDL protocols and modeling compendium, and recommendations on various 303(d) listing issues. He has responded to numerous quick response requests for technical review and consultation. Mr. Kratt is familiar with most of the loading and receiving water quality models used for TMDL development, including their strengths and weaknesses for various applications.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt’s Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

James Stribling
Dr. Stribling is an aquatic ecologist with 19 years of experience in applying ecological principles to water resource management decision making. He has been directly involved in developing field sampling and data analysis methods for the U. S. Environmental Protection Agency for the assessment of biological condition, physical habitat quality, and landscape integrity. He has developed approaches for evaluating the precision and accuracy of data used for biological assessments and overall quality assurance/quality control (QA/QC). Dr. Stribling has designed stream and watershed assessment programs for the examination of ecological condition based on biology, physical habitat quality, the presence (or absence) and relative intensity of human activities, and the role those activities play in influencing ecological condition. He is also currently involved in sample design and data analysis for Georgia and Mississippi.
He has authored over 30 environmental studies and reports that have focused on the ecological effects of surface coal mining, agricultural and urban stormwater discharges, hazardous waste sites, environmental responses to physical habitat restoration, accidental spills of industrial chemicals, paper mill effluent, transportation facilities, regulatory compliance, combined sewer overflows (CSO), and urban and suburban development.

Julie Tsatsaros
Ms. Tsatsaros is a Senior Environmental Scientist with ten years experience in the environmental field focusing

on all aspects of surface water quality, watershed, and assessments and studies. Ms. Tsatsaros has over five years of Total Maximum Daily Load (TMDL) experience. She has an extensive background in designing, implementing, and conducting fieldwork and sampling. She also has a strong laboratory background. Ms. Tsatsaros has experience consulting with State/Tribal/Federal agencies, as well as research oriented studies. A former employee of the New Mexico Environment Department (NMED), she is familiar with western water quality issues, and the complex issues found in this region.

Lei Zheng
Dr. Zheng is a research scientist with extensive experience in the field of aquatic ecology and ecological statistics. He has participated in a wide range of multi-disciplinary investigations and research projects, which focus predominantly on the biological assessment of aquatic systems. His strong background in multivariate statistical analysis has helped to integrate complicated information into simple models and matrices for a variety of projects. Dr. Zheng's research is towards developing diagnostics (identifying causes) for biological impairment. He has applied statistical modeling technique to identify the cause of impairment. As an expert on periphyton identification and data analyses, Dr. Zheng has used innovative approaches to develop nutrient and biological criteria for biological impairment. Dr. Zheng possesses technical abilities including but not limited to statistical design and analyses, wetlands ecology, stream ecology, and periphyton-nutrient relationships, and extensive experience in developing indicators for ecological impairment in aquatic systems.

2.1.3 Method of Providing Services and Quality Assurance

Our national leadership in TMDL development is due in large part to our ability to review, comprehend, and interpret state water quality standards. Thorough understanding of water quality standards is the key to crafting justification for de-listing waters that are not impaired and developing approvable TMDLs. For some waters, the indicators and target values needed for TMDL development already are specified as numeric criteria in state water quality standards. An example would be a standard that specifies that the daily minimum dissolved oxygen concentration in a river designated for warm water aquatic life support must be 5.0 mg/L. However, water quality standards vary considerably from state to state and often only narrative criteria exist for pollutants such as sediment, nutrients, and temperature. In these situations, development of the TMDL will require the identification of one or more appropriate indicators to quantify the attainment of water quality standards. When available, the numeric standard will be used as the TMDL indicator and target value. If numerical criteria are not available, or if supplemental indicators are needed, the selection can be based on both scientific or technical considerations and practicality and cost considerations. The target value for a chosen indicator is often based on: comparison to similar but unimpaired waters; user surveys; empirical data summarized in classification systems; literature values; or best professional judgment. The narrative standard is then interpreted to develop a quantifiable target.

Our work in selecting targets for the Dearborn River TMDL Planning Area (TPA) in Montana offers a good example of the methodology we will use to complete projects in this service category. For this project we first obtained all available data related to biology, riparian conditions, water chemistry, and landscape-scale factors within the watershed. This process included downloading data from national databases such as STORET and NWIS as well as using DEQ's STOREASE database. It also included making phone calls to various individuals with USGS, FWP, USFS, and DNRC. Once all the data were compiled, they were initially reviewed to determine if sufficient data were available to make use support determinations. Since they were not, a Sampling and Analysis Plan was developed and field crews visited the watershed for several weeks in 2003. During these field visits additional information was collected on pebble counts, riparian vegetation, macroinvertebrate conditions, periphyton, and water chemistry. Tt subcontracted the macroinvertebrate data processing with Wease Bollman and the periphyton processing with Loren Bahls.

Once all of the old and new data were available an extensive process of identifying TMDL targets began. This required a lot of research and discussions with local experts because there has been a good deal of variability in sediment TMDL targets used in Montana. Final targets were not selected until DEQ's Sediment TMDL Targets Workshop was completed. The targets and supplemental indicators were eventually chosen as described in the table below. The targets are the most reliable and robust measures of sediment impairment and beneficial use support available because there is a documented relationship between the selected target values and beneficial use support, or sufficient reference data is available to establish a threshold value representing "natural" conditions. The supplemental indicators provide supporting and/or collaborative information when used in combination with the targets. Additionally, some of the supplemental indicators are necessary to determine if exceedances of targets are a result of natural or anthropogenic causes.

Table 2-2. Summary of the Proposed Targets and Supplemental Indicators for the Dearborn River TPA.

Sediment Target	**Proposed Metrics**
Percent Surface Fines < 2mm	< 20 percent
Sediment – Supplemental Indicators	**Proposed Metrics**
Westslope Cutthroat Trout Density	Documented increasing or stable trend
Macroinvertebrate Population	Analysis of site-by-site scores and metrics: Multimetric Index, Individual Metrics (Percent tolerant taxa, # of EPT taxa, Percent clingers, # of clinger taxa, and HBI), Stressor Tolerance of Dominant Taxa
Periphyton Population	Siltation Index
Riparian Condition	No significant disturbances
Suspended Sediment Concentration	Comparable to reference condition
Turbidity	High Flow – 50 NTU instantaneous maximum Summer base flow – 10 NTU
Anthropogenic Sediment Sources[1]	No significant sources

[1] This supplemental indicator is only applied to the verification of impairment determinations. This is not intended to be a water quality goal.

These targets and supplemental indicators were then used with a "weight-of-evidence" approach to determine full use support. The weight of evidence approach was applied as follows. If none of the target values are exceeded, the water is considered to be fully supporting its uses and no TMDL is necessary. This is true even if one or more of the supplemental indicator values are exceeded. On the other hand, if one or more of the target values are exceeded, the circumstances around the exceedance are investigated and the supplemental indicators are used to provide additional information to support a determination of impairment/non-impairment. In this case, the circumstances around the exceedance of a target value are investigated before it is automatically assumed that the exceedance represents human-caused impairment.

All of the data and analysis associated with the application of these targets and supplemental indicators were summarized in a Watershed Characterization and Water Quality Impairment Status Report for the Dearborn TPA. Draft TMDLs were then developed for those segments determined to be impaired.

2.1.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Mr. Jason Gildea, is provided above.

Table 2-3. Staff qualifications for service category 3.5.4 (TMDL Targets).

Name	**Highest Degree**	**Discipline**	**Natural Sciences Degree?**	**Years Experience[1]**	**Rate**
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74
Clint Boschen	M.S.	Biological Sciences	Yes	7/7	101.72
Shad Bowman	B.S.	Physics/Environmental Biology	Yes	7/7	84.64
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77

John Craig	M.S.	Marine, Estuarine, and Environmental Science	Yes	14/14	154.51
Jeroen Gerritsen	Ph.D.	Ecology and Evolutionary Biology	Yes	25/25	140.70
Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Nick Jokay	M.S.	Applied Geomorphology	Yes	4/4	67.18
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Kevin Kratt	M.S.	Water Resources	Yes	8/8	121.24
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
James Stribling	Ph.D.	Entomology	Yes	19/19	121.22
Julie Tsatsaros	M.S.	Limnology	Yes	10/10	92.13
Lei Zheng	Ph.D.	Ecology, Evolutionary Biology, and Behavior	Yes	16/16	77.92

2.2 Service Category 3.5.5: TMDL Source Assessment/Delineation

Tt understands that the source assessment component of TMDL development is critical to eventually implementing restoration activities that will lead to the attainment of water quality standards. Through our development of more than 2,000 TMDLs we have employed a wide variety of techniques to identify and quantify source loadings, both by land use and by category. These include field-based monitoring and review of aerial photos as well as desktop modeling.

2.2.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references. Please note that Tt has completed more than 2,000 TMDLs nationwide over the past ten years and therefore the table below represents only a very small subset of our work in this area. Multiple TMDL projects have been completed for most of the references in the table shown below.

Table 2-4. Summary of references for Service Category 3.5.5: TMDL Source Assessment/Delineation.

Reference Information	Description of Service
Ron Steg USEPA Region 8 Montana Operations Office Helena, MT (406) 457-5024	For EPA Montana Operations Office, Tt is working closely with Land and Water Consulting to develop sediment, nutrient, and metal TMDLs for the Lake Helena watershed. Land and Water Consulting, with Tt assistance, has conducted a source assessment as part of the field activities to identify specific pollutant sources. This information has been input to a dynamic watershed model that Tt is applying that quantifies source loadings for the various parts of the watershed. Tt will continue to work with EPA and the Lake Helena Technical Advisory Committee as the TMDLs are finalized during the summer and fall of 2004. *Dates: October 2002 to Present*
Jayne Carlin TMDL Specialist USEPA Region 10 1200 Sixth Avenue Seattle, WA (206) 553-8512	Several waterbodies within the Coeur d'Alene reservation are included on Idaho's 303(d) list for nutrients and sediments. Tt performed extensive data analysis to identify TSS and turbidity values representative of background, target and existing conditions for a variety of flow ranges. Using identified targets and an evaluation of the distribution of flow, Tt calculated loading capacities and necessary load reductions for the stream under different flow conditions. Tt is also developing TMDLs for nutrients and sediments for Fighting Creek, using Generalized Watershed Loading Function to simulate watershed loadings. Future TMDLs include sediment and nutrient TMDLs for Black Lake and Willow Creek. *July 2000 to Present*

Palma Risler EPA Region 9 Water Division San Francisco, CA (415) 972-3451	Tt is providing support for the development of a temperature TMDL for the North Fork Eel River. The temperature impairment is due in large part to disturbances in riparian zones that allow increased solar radiation to reach the waterbody and other geomorphic changes associated with increased sediment loads. The NF Eel is part of a consent decree settlement and EPA is developing the TMDL under a strict schedule. Tt is developing a GIS-based model that will estimate the heat load (from solar radiation) to the stream. The analysis will be compared to an interpretation of the state's narrative temperature standard that will include statistical analysis of available data. The analysis will compare existing riparian condition with site potential vegetation to determine load allocations. The structure of the model will allow CA and EPA to continue using the approach for other north coast waterbodies. *Dates: June 2003 to Present*
Thomas Henry TMDL Coordinator USEPA Region 3 Philadelphia, PA (215) 814-5752	In response to court-ordered schedules for TMDL establishment, Tt provided technical support to EPA Region 3 in the development of mining related TMDLs addressing metals impairments for the Tygart Valley River Watershed, West Virginia. The effort involved development of an innovative assessment and modeling technique, Mining Data Analysis System (MDAS), to address a variety of case-specific requirements related to water quality criteria, water use designations, source pollution conveyance methods, and permitting. Many of the impaired segments were small nested tributaries and had various water use designations that require specific acute and chronic numeric criteria. Over 300 permitted mining discharges, in multiple phases of reclamation (exhibiting various water quality conditions) were represented as point sources that simulated characteristics of precipitation driven discharges. Final TMDL allocations were assigned to more than 1,000 subwatersheds and over 80 individual mining facilities and resulted in the development of over 150 individual TMDLs for the watershed. Tt also provided technical support at public meetings and provided technical training to EPA Region 3 and its states. *Dates: October 1999 to March 2001*
Jeremy Sokulsky Water Resource Control Engineer Lahontan Regional Water Quality Control Board Lake Tahoe, CA 530-542-5463	Tt developed a copper TMDL for Haiwee Reservoir located in Inyo County, California. The primary source of copper to the reservoir is the application of copper sulfate to control algae within the reservoir system as well as the upstream portions of the Los Angeles aqueduct. The copper concentrations from these applications have resulted in fish kills in the reservoir, from either direct toxicity or reduced dissolved oxygen levels caused by algal decomposition. The availability of data to represent the hydrologic and water quality characteristics of the Haiwee Reservoir system provided an opportunity to develop a site-specific model that could be used as an assessment tool for the TMDL process as well as a management tool for the primary stakeholder. The Haiwee Reservoir Copper Model was developed using Mircosoft Excel as the platform and user interface. The model's computational scheme is comprised of three layered components, water balance, sediment budget, and copper mass balance. The resulting calibrated model is useful for testing various operational scenarios and performing loading-source and water quality analyses. *Dates: January 2001 to August 2001*
Kent Montague Utah DEQ Division of Water Quality Salt Lake City, UT (801) 538-6057	Tt has worked with the Virgin River Advisory Committee and Utah DWQ to develop a suite of TMDLs for the Virgin River watershed in southwest Utah. Extensive work was conducted as part of the TMDL to determine the most significant sources of TDS, nutrients, and selenium. An aerial photo survey was conducted as well as on-the-ground field surveys. The information used from these activities were fed into a series of spreadsheets to estimate pollutant sources. In addition to developing a Project Implementation Plan, conducting a use attainability analysis, developing a TMDL and a Surface Water Source Protection Plan, Tt is also developing a Watershed Management Plan for the Virgin River watershed. The Watershed Management Plan will include management and project recommendations that are responsive to key project issues. The Watershed Protection Plan will belong to the residents of the watershed and focus on issues including water rights, right-to-farm proposals, recreational needs, wetland protection, and property rights. *Dates: July 2002 to Present*

2.2.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including source assessment activities, to support TMDL development, to state, local, and federal agencies. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and 40 states. Our experience dates back to the opening of the Center for Water Resources office in 1976 but has significantly increased during the past 10 years as the TMDL program has expanded nationwide. All work has been performed under the company name Tetra Tech, Inc.
This section provides biosketches for the key personnel who will provide primary support in this service category. We have many other specialists with extensive TMDL experience that cannot be shown due to the 20-person limit specified in the RFP. Full resumes of all personnel described below are provided in Appendix A

Kevin Kratt (Project Manager)
Mr. Kratt has more than eight years of experience in water resources analysis for point and nonpoint source pollution in both urban and agricultural areas. This experience includes watershed modeling, water quality analysis, selection of water quality targets, and evaluation of best management practices (BMPs). He has also been extensively involved in the national and local evaluation of TMDL development activities and in various point and nonpoint source policy issues. Mr. Kratt has been supporting EPA and various state agencies on the TMDL and related programs since 1995. He has provided technical and programmatic support to all phases of the TMDL program, from guidance development, technical reviews, and TMDL development, to national training and facilitation. His support has included review of numerous TMDLs, technical oversight for more than a hundred TMDL development projects throughout the United States, development of new TMDL course materials, development of the first TMDL protocols and modeling compendium, and recommendations on various 303(d) listing issues. He has responded to numerous quick response requests for technical review and consultation. Mr. Kratt is familiar with most of the loading and receiving water quality models used for TMDL development, including their strengths and weaknesses for various applications. Mr. Kratt has been supporting EPA and DEQ on Montana TMDL development activities for the past two years.

Andrew Parker
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Clary Barreto-Acobe
Ms. Barreto is a water resources/environmental engineer with four years of professional experience and two years of research experience in the areas of hydrodynamics, water quality modeling, sediment transport, coastal processes and groundwater hydrology. She has developed and applied computer models to simulate the fate and transport of pollutants in streams, lakes, estuaries and coastal regions. Her area of expertise is sediment-water interaction. Ms. Barreto is proficient in the use of ArcView GIS, Microsoft Access, Mining Data Analysis System (MDAS), Loading Simulation Program in C++ (LSPC), BASINS, HEC-HMS, HEC-RAS and MODFLOW. She has significant experience programming in C++, FORTRAN, and MATLAB. Ms. Barreto is also fluent in English and Spanish.

Clint Boschen
Mr. Boschen has more than seven years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He has supported Clean Water Act programs at the state and national level and is currently involved in TMDL development projects and biological assessment studies throughout the country. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. He routinely conducts watershed studies focusing on the assessment of biological condition in relation to pollutant levels and anthropogenic impacts. Mr. Boschen has experience in planning and conducting field monitoring studies, watershed characterization and modeling, wetland and stream corridor assessments, and water quality planning activities. His academic and research experience is in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Shad Bowman
Mr. Bowman has over 7 years of experience with various water resources issues involving Total Maximum Daily Loads (TMDLs), surface water quality standards, drinking water, and ecological studies. Mr. Bowman is familiar with ecosystems of the western United States, and has participated in several projects for TMDLS, water quality standards, restoration projects, outreach, and policy development in regards to differing ecosystems. Mr. Bowman has served as a project manager for over 110 TMDLs that addressed various contaminants, stream reaches, and conditions. He has been directly involved in the development of over 200 total TMDLs. He has been involved in, and responsible for, all phases of the TMDL development process, from water quality standards review and development, to impairment assessments and determinations to delisting and TMDL creation, and implementation and restoration planning. In addition to TMDLs, Mr. Bowman has been involved in the development of surface water quality standards development, rule and policy development activities, sampling plan development, 303(d) and 305(b) assessments, data analysis, database development, and public meeting facilitation and outreach activities. Mr. Bowman has designed developed and presented several workshops, trainings, and presentations dealing with TMDLs, Implementation, Source Assessments, and Stream Restoration.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

John Craig
Mr. Craig is a water resources specialist with more than 14 years of experience evaluating watershed and water quality problems and providing support for federal, state, and local policy issues. His areas of expertise include watershed management, Total Maximum Daily Load (TMDL) development and training; water quality assessment; and risk assessment. Currently projects include management of a nutrient criteria pilot study in Montana and North Dakota; management of a nutrient assessment for the watersheds of Lake Elsinore, CA; management and technical support for the development of nutrient and pathogen TMDLs for the Los Angeles River; and management and development of a watershed management plan and TMDL for Pineview Reservoir, Utah. Mr. Craig currently serves as the director of Tt's Fairfax Water Resources department and has been providing ongoing management and technical support for local, state, and federal water programs in the south and west.

Scott Daly
Mr. Daly is an environmental scientist with 2 years experience in watershed management, biomonitoring, and data analysis. He is proficient in aqueous chemistry, hydrologic and geomorphic processes, and taxonomic identification of freshwater macroinvertebrates. In addition, Mr. Daly has knowledge of surface water, ground water, aquatic ecosystems, geology, and statistics. While at Slippery Rock University his course work consisted of Organic Chemistry, Earth Materials, Geomorphology, Ecology, Environmental Microbiology, Biometry, Hydrology, Freshwater Biomonitoring, and Water Quality Assessment. He is also proficient with Corel 9, MS Office, SAS, Arc View, BASINS, Spatial Analyst, 3D Analyst, Network Analyst, and additional GIS tools.

Mustafa Faizullabhoy
Mr. Faizullabhoy is a water resources/environmental engineer with more than 2 years of professional experience in the areas of water quality modeling, storm water management planning and design, hydrologic and hydraulic modeling, open/closed storm drain design and analysis, storm water sampling, and TMDL development. He has developed TMDLs for EPA Regions 3, 4, and 9 for a variety of pollutants and waterbody types. For the development of a copper TMDL for Haiwee Reservoir, CA, he supported the development of a model to simulate the sediment water column interaction for copper in the reservoir. Currently, Mr. Faizullabhoy is supporting several EPA engineering and cost studies for BMPs associated with several agricultural industries. He is also providing support for the development of TMDLs for Newport Bay and the application of CE-QUAL-W2 for a modeling study for the Tongue River Reservoir in Montana.

Ana García
Dr. García has extensive experience in the mathematical modeling of fundamental physical phenomena, with an emphasis on watershed modeling. Her graduate work, both at the Master's and Ph.D levels, involved the development of new simulation models. She developed a simulation model to solve various environmental problem, including subsurface and channel flow in tile drained watersheds. She has published several academic articles in water resources as well as in mechanical engineering journals. At Tt, Dr. García has been the lead modeler for an extensive modeling study of the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana and northeastern Wyoming. She has also applied her expertise in agro-hydrology in the development of several TMDLs for US EPA Regions 4 and 5, Ohio EPA, Illinois EPA and Indiana Department of Environmental Management (IDEM). She also works on quality assurance issues as they pertain to the use of water quality and hydrologic models in TMDL development.

Jessica Koenig
Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Yoichi Matsuzuru
Mr. Matsuzuru is an environmental scientist with 6 years of professional experience in Water Resource field. The experiences include developing the Total Maximum Daily Load (TMDL) Program under Clean Water Act section 303(d) in South Carolina, West Virginia, Arizona, and Florida state government. He also has a field research experience in assessing biogeochemical cycles in subsurface and surface water at the Southeastern Tree Research and Education Site Project in North Carolina. He has a programming skill in FORTRAN and other computer languages. He is currently the task leader for the technical support and development of South Carolina's pathogens TMDLs.

Teresa Rafi
Ms. Rafi has more than 7 years of professional experience in public sector environmental science and policy. She has supported numerous aspects of the Coastal Zone Management and Clean Water Acts at both the state and national levels, performing public outreach, interagency coordination, and conflict resolution. She has been a member of the Water Resources Group at Tt, since October 2000, where her activities include TMDL development for fecal coliform and metals-impaired waterbodies, curriculum development for watershed modeling courses, and database development in support of numerous EPA programmatic initiatives. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques, developing strategies for and conducting public outreach initiatives, meeting facilitation, and development of management indicators for gauging program performance.

John Riverson
Mr. Riverson is a water resources engineer with five years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He also has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. He has published engineering and business instructional material for the Darden School of Business Administration (University of Virginia), and has played a supporting role in providing technical analysis, narratives, schematics diagrams, and technical figures for two engineering textbooks and various peer-reviewed technical papers. Mr. Riverson has worked on a variety of projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several state and county water resource operatives, and the US Army Corps of Engineers.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt's Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

Nancy Sullins
Ms. Sullins has 20 years of project management experience with over 9 years of experience concentrated in regulatory water quality issues. This experience includes receiving water modeling (QUAL2E, WASP, WQMap, BRANCH/BLTM, EFDC, CE-QUAL-W2, CORMIX, STELLA and CWQM), water shed modeling (LSPC, GWLF), water quality analysis, selection of water quality targets, standards interpretation, water quality evaluations for Environmental Impact Assessments and Environmental Impact Statements as well as NPDES permit limit development. She has also been involved in various point and nonpoint source policy issues such as nutrient load trading and atmospheric deposition. She is experienced in the application of dynamic multi-dimensional water quality models used to determine TMDLs and NPDES permit limits in fresh water and estuarine systems. She has been actively involved in several projects focusing on water quality standards and

methodology development.

Julie Tsatsaros
Ms. Tsatsaros is a Senior Environmental Scientist with ten years experience in the environmental field focusing on all aspects of surface water quality, watershed, and assessments and studies. Ms. Tsatsaros has over five years of Total Maximum Daily Load (TMDL) experience. She has an extensive background in designing, implementing, and conducting fieldwork and sampling. She also has a strong laboratory background. Ms. Tsatsaros has experience consulting with State/Tribal/Federal agencies, as well as research oriented studies. A former employee of the New Mexico Environment Department (NMED), she is familiar with western water quality issues, and the complex issues found in this region.

2.2.3 Method of Providing Services and Quality Assurance

A critical component of all watershed and water quality studies is the compilation of data and information that can be used to quantify the loadings of the pollutants, and analyze the connection between point and nonpoint loadings and in-stream response. Numerous approaches are available to support this analysis from strategic monitoring, GIS-based screening procedures, land use-based loading coefficients, and the application of watershed models. Because our primary business area involves the development of TMDLs and watershed plans, our staff has accumulated the full range of sampling and source identification and load determination methods. We have not only applied the full range of techniques, we have customized many of the procedures available to facilitate their use as management tools. We have developed web based applications to allow clients and watershed communities to review and comment on spatial data. For example, the web based mapping application shown below allows the state agency to display, query, review, and analyze a variety of data sources.

As part of the source identification and assessment component, each source area in a watershed will benefit from a strategic analysis approach including:

1. Preparation of data inventory and identification of data gaps
2. Targeted monitoring and data collection plans
3. Identification and evaluation of possible sources of the listed pollutants
4. Estimation of the loads associated with each source
5. Allocation of loads among sources to meet water quality standards
6. Evaluation of management options, feasibility, and cost

Each of the steps associated with the source assessment process is discussed in more detail below.

Preparation of Data Inventory

One of the first steps in the assessment process is to review all existing data resources including stream flow, water quality, permitting, and weather data. Also the historic, existing, and future land uses for the basin must be compiled and reviewed for quality control or developed if not available. One of the methods we have employed to streamline the data compilation process is the use of GIS-based data management tools. For example, our staff developed the BASINS modeling system, which contains environmental data for the entire US and is linked to several public domain, EPA-approved models. In addition, for EPA Region 4, we developed the Watershed Characterization System (WCS), which is a comprehensive GIS-based database that allows processing and direct transfer of information to watershed models. WCS has the benefit of allowing ready access by agency staff, modelers, and other interested parties and provides an archive of project information. Because WCS is a non-proprietary freely distributed system developed specifically for archiving and processing spatial data for EPA Region IV, it provides a user friendly accessible platform for the transfer and dissemination of all spatial data. A GIS-based data management approach is critical for providing a spatial depiction of the flow and water quality sources and the movement within a basin. Having this GIS-based data management tool for all data sources, especially for soils and land use coverages, will quickly allow non-permitted point and nonpoint sources within a basin to be identified and categorized.

The identification of data gaps in support of the development of the models/methods for evaluation of water quality is highly dependant upon the model system utilized. Therefore we typically recommend that this be completed in parallel with the development of the conceptual model of a basin and the model/method selection process. This will assure that all recommendations relative to additional data needs reflects directly the needs of this project and minimizes potential waste of resources and monies. The determination of data gaps will be a two-phase process; the first phase will identify all areas of data limitation without consideration of priority relative to project goals. The relative importance of missing data will then be prioritized based upon needs of the project and model development–this prioritized list may then be used to support additional monitoring activities.

Strategic or targeted monitoring and data collection plan.

Review of available data will often identify targeted sampling needs to adequately meet DEQ requirements, characterize sources, test analysis approaches, or evaluate compliance or delisting actions. A Sampling and Analysis Plan (SAP) that meets the needs of TMDL development for a waterbody will be dependent upon the initial evaluation of existing data, the spatial and temporal resolution of that data, its accuracy, precision, completeness, and reliability and whether or not the data meet the requirements for models expected to be used for the TMDLs. The SAP for a TMDL project must provide data that satisfies three key objectives in order for DEQ to make informed decisions about the resource. These objectives include:

- Developing information necessary for the DEQ to determine if the existing designated uses and criteria are appropriate and, if not, develop information necessary for the DEQ to change the designated use and/or applicable criteria;
- Developing information necessary for the DEQ to determine if the impaired areas are meeting applicable water quality standards; and
- Developing information necessary to support source assessment activities required to allocate pollutant loadings contributing to all impaired areas where water quality standards are not being met.

Data required to satisfy these objectives are complementary to some degree, but not completely overlapping. These objectives together with the historical data review define the basis for the nature and extent of sampling and monitoring efforts necessary in the area of interest.

Because the SAP and Quality Assurance Project Plan (QAPP) are inherently intertwined documents, we expect that the SAP and QAPP will be developed concurrently. In fact, prior to SAP development, the Data Quality Objectives (DQOs) from the QAPP will be formulated to assure that the SAP will meet those objectives. The historical data assessment may identify that additional sample locations for a waterbody are necessary either to meet the spatial resolution requirements for modeling or to meet the additional data requirements to assess the waterbody's impairment. Specific locations for monitoring will be defined in large part based on the locations where existing sample data have been collected. Key information for identifying sampling locations will include location coordinates, maps, and location descriptions. If additional sample locations are to deemed necessary, a preliminarily office mapping exercise will be conducted to identify potential additional sampling locations. This exercise will be followed up by a reconnaissance level survey to evaluate existing as well as additional sampling locations prior to the implementation of any sampling efforts. This reconnaissance level survey will be used for focusing sample locations, particularly in assessing specific features, such as a point source discharge or areas of non-point source loadings, and placement of automated storm sampling units, if needed for the waterbody assessment.

If storm event samples are to be collected, the SAP will identify the requirements of what constitutes a storm event for the waterbody, the frequency and duration of sample collection during the storm event, the responsible individuals who will be required to attend to the storm event sampling and pull samples from the automated sampler to insure that samples can be delivered to the laboratory in a timely fashion. Monitoring may include the following components to support the objectives of the work:

- Water quality monitoring - synoptic, surficial and depth integrated sampling and storm event monitoring;

- In situ monitoring - synoptic and diel 24-hour monitoring (for certain parameters, depth integrated sampling maybe implemented);
- Biological surveys - fish, benthos, phytoplankton, zooplankton, macrophytes; and
- Physical surveys - physical stream surveys, physical reservoir characteristics such as bathymetry, surface area, shoreline quality, vertical illumination, reservoir hydrology (retention time, stratification and mixing, circulation, etc.), and in-reservoir habitat quality (shoreline and littoral habitats).

Other targeted sampling or data collection efforts might be identified such as livestock or agricultural practices, mining remediation status and effectiveness, extent of abandoned or historic mining activities, or various remote sensing or aerial photography needs. Compilation of this site specific data, at a more detailed level than the statewide coverages, could provide improved analysis for TMDLs, more effective management plans, and ultimately more efficient implementation.

Identification and evaluation of possible sources of the listed pollutants

The identification of possible pollutant sources within a watershed can be approached in many different ways depending on factors such as data availability, resources available, and the implications associated with the analysis. For example, in northern California, numerous waterbodies are impaired because of excessive sediment loading, which, among other things, has reduced spawning habitat for salmonids.

Because of factors such as access difficulties (both terrain and land owners), limitations in the science of sediment modeling, and watershed size, the source assessments conducted by EPA and Tt have focused on the use of remote sensing techniques combined with GIS. This technique provides an acceptable level of analysis (in this case an order-of-magnitude estimate) and provides sufficient detail to confidently identify critical areas to be targeted for BMPs and additional monitoring. This approach, acceptable for a given set of circumstances, may not be acceptable in other areas. Because of our extensive national experience and our reputation for developing approvable TMDLs, we are able to provide recommendations on a source assessment technique with sufficient technical rigor–we typically endorse the simplest method that can be applied given the factors identified above.

When investigating the type and location of all permitted and non-permitted point source discharges as well as the identification of potential nonpoint sources throughout a watershed, we correlate the potential sources with impaired waters and the parameters of impairment. This is a critical design criteria for determination of the kinetic components of the watershed loading and in-stream water quality modeling. Tt has extensive experience in the identification of potential pollutant sources through the successful completion of an unprecedented number of TMDL studies and other watershed projects. The ability to quantitatively assess point and nonpoint sources at the receiving water and watershed scale is crucial to the development of pollution loading analyses and, ultimately, the effective application of pollution abatement strategies and the placement of BMPs.

Existing Permitted Discharges

Tt has the capability to download NPDES information from EPA's Permit Compliance System (PCS) database and use state compiled databases. We can link databases to NHD, as demonstrated through the most recent release of BASINS 3.0. Point source data can be used to identify active and inactive point source dischargers within a watershed and to retrieve facility information, permit limits, and Discharge Monitoring Report (DMR) data. This point source inventory provides for an exchange of information with state and local regulatory agencies in order to accurately identify point sources within a watershed. Site inspections, facility records, and other information are then obtained in order to characterize each contributing source for loading analyses. Verification of point source is important because in many instances the data reflect discharges that are no longer active or have altered their treatment process. Tt personnel will work closely with DEQ personnel and local municipal and county personnel to assure the accuracy of the data. As with all temporal data, these data will be archived within a database and tagged by location and reach.

Significant Nonpoint Source Discharges

Data inventories and point source summaries will be used to determine the known sources and their significance in the overall source-loading budget. A screening-level loading model can be used to provide an initial examination of the loading from diffuse nonpoint sources throughout the basin. Tt has developed numerous loading techniques and has recently compiled a comprehensive inventory of loading rates from modeling and monitoring studies throughout the U.S. We find that a screening-level loading analysis can identify the relative magnitude of sources, provide a basis for comparison with identified point source loadings, and indicate potential areas where additional sources need to be identified or better characterized. Results of the screening-level analysis can be used to support identification of data gaps and target future reconnaissance efforts for unmonitored or undocumented nonpoint sources. Of particular concern are concentrated land uses that do not require permitting but potentially contribute significant loadings of nutrients. Often we have identified sources such as golf courses, septic systems, or animal operations for separate loading evaluations specific to local conditions. Often we use spreadsheets and inventories to identify potential loading based on source inventory data. For pathogen sources we use a spreadsheet to identify potential loading from livestock and wildlife counts and other survey information. These potential loading evaluations can be used to support implementation planning. Although not always important, the evaluation of the potential for atmospheric loading is critical to provide a complete pollutant source balance within a basin. Tt is fortunate to have staff with extensive experience in conducting atmospheric deposition research throughout the continental United States. Our experience with atmospheric deposition research extends back to the early 1980's.

Estimation of the loads associated with each source

Watershed assessment refers to the review and analysis of all data related to the physical aspects of the landscape and point and nonpoint sources contributing to the impairments. Watershed data critical to modeling for TMDLs include land use, geology, soils, meteorology/climate, land practices, waste treatment, and point source discharges. Critical nonpoint sources will be different depending on the pollutant types. For example, MT's 2004 303(d) list includes watersheds listed as impaired by sources that include mining, agriculture, and forestry. The sources involved in these watersheds might be addressed using loading estimation tools such as sediment loading models and MDAS (a mining modeling systems applied to predict loadings and compare directly to metals and pH criteria). All point and nonpoint sources will be fully assessed during the data review process. Data to support the assessment is typically obtained from stage agencies (e.g., DEQ), USDA, NRCS, Census Bureau, USGS, BLM, Forest Service, local extension services, universities, and other federal and local agencies. The assessment process will include identification of available data, summary of watershed conditions, initial estimation of watershed source contributions, and identification of additional necessary data. Tt will follow procedures derived from decades of watershed assessment experience and apply tools developed in-house, such as the Watershed Characterization System (WCS), to expedite the process. We use a variety of load estimation tools when appropriate. For Pend Oreille Lake we recently developed estimates using loading rate assumptions for land use classes based on the larger scale estimates used in the lake wide study and recent local literature values. We recently compiled a national survey of loading rate models by land use, ecoregion, and geology.

2.2.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person’s full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Mr. Kevin Kratt, is provided above.

Table 2-5. Staff qualifications for service category 3.5.5 (TMDL Source Assessment/Delineation).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74

Clary Barreto-Acobe	M.S.	Environmental Engineering	Yes	4/4	47.20
Clint Boschen	M.S.	Biological Sciences	Yes	7/7	101.72
Shad Bowman	B.S.	Physics/Environmental Biology	Yes	7/7	84.64
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
John Craig	M.S.	Marine, Estuarine, and Environmental Science	Yes	14/14	154.51
Scott Daly	B.S.	Environmental Science	Yes	2/2	51.05
Mustafa Faizullabhoy	M.S.	Civil/Environmental Engineering	Yes	4/4	81.58
Ana Garcia	Ph.D.	Agricultural Engineering	Yes	5/5	88.67
Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Kevin Kratt	M.S.	Water Resources	Yes	8/8	121.24
Yoichi Matsuzuru	M.S.	Water Resources	Yes	4/4	87.72
Teresa Rafi	B.A.	Environmental Science	Yes	7/7	87.86
John Riverson	M.S.	Civil/Environmental Engineering	Yes	5/5	104.79
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
Nancy Sullins	M.P.H.	Environmental Quality	Yes	20/20	102.50
Julie Tsatsaros	M.S.	Limnology	Yes	10/10	92.13

2.3 Service Category 3.5.6: TMDL Load Allocations

Developing an understanding of the magnitude of each source, its geographic location, and the sensitivity of the receiving water to changes in source loading, is essential to supporting selection of feasible allocation scenarios. Prior to establishing a final allocation, a set of feasible alternatives should be developed, taking into account the level of control for each source or source category necessary to achieve water quality targets. Tt is committed to identifying a set of technically feasible allocation scenarios and then working closely with DEQ and stakeholders to ensure that the final scenario is politically and practically feasible. The determination of a technically-sound and equitable TMDL allocation strategy will also potentially require the consideration of numerous BMPs both individually and in combination. For each pollutant source, Tt will provide a summary of BMPs and BATs that are appropriate for the pollutants under consideration. This analysis will be based on past studies and databases developed by Tt, literature reviews, and input from stakeholders and state, federal, and local agencies. The summaries will include general information on the cost of implementation, operation, and maintenance, the effectiveness in reducing concentrations or loadings, and the strengths and limitations of each.

2.3.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references. Please note that Tt has completed more than 2,000 TMDLs nationwide over the past ten years and therefore the table below represents only a very small subset of our work in this area. Multiple TMDL projects have been completed for most of the references in the table shown below.

Table 2-6. Summary of references for Service Category 3.5.6: TMDL Load Allocations.

Reference Information	Description of Service
Michael Pipp Montana DEQ Helena, MT (406) 444-7424	For Montana DEQ, we are evaluating TMDL load allocations for the Flathead River basin. In consultation with key DEQ staff, a Soil and Water Assessment Tool (SWAT) model for each major subbasin is being constructed. The models are being developed at a sufficient spatial scale that captures the heterogeneity of land use/land cover, soils and topographic characteristics in each subbasin. The model will be used to estimate nonpoint sources of sediment and nutrients. Once calibrated and validated, the modeling tools will be used to evaluate various land use/land cover changes on sediment and nutrient delivery in Flathead River basin. Scenarios will be defined in close consultation with DEQ, and will be congruent with their long-range planning efforts. *Dates: August 2003 to present.*
Kent Patrick-Riley Alaska Department of Environmental Conservation Anchorage, AK (907) 269-7554	For Alaska DEC we supported TMDL development in Chester Creek, a large urban watershed, by modeling fecal coliform loadings to the creek with the use of the Storm Water Management Model (SWMM). Tt staff provided intensive spatial data compilation and analysis to develop the required input for the SWMM. SWMM was used to assess the relative contribution of fecal coliform from various subbasins, as well as land uses within those subareas. Important diffuse sources of fecal coliform were found to be residential lawns and waterfowl inhabiting parks and wetlands. Once the source areas were described, appropriate BMPs were identified for the Chester Creek watershed in collaboration with the state and local stakeholders. *Dates: July 2002 to June 2004*
Ron Steg USEPA Region 8 Montana Operations Office Helena, MT (406) 457-5024	For EPA Montana Operations Office, Tt is working closely with Land and Water Consulting to develop sediment, nutrient, and metal TMDLs for the Lake Helena watershed. Land and Water Consulting, with Tt assistance, has conducted a source assessment as part of the field activities to identify specific pollutant sources. This information has been input to a dynamic watershed model that Tt is applying that quantifies source loadings for the various parts of the watershed. Tt will continue to work with EPA and the Lake Helena Technical Advisory Committee as the TMDLs are finalized during the summer and fall of 2004. *Dates: October 2002 to Present*
Jayne Carlin TMDL Specialist USEPA Region 10 1200 Sixth Avenue Seattle, WA (206) 553-8512	Several waterbodies within the Coeur d'Alene reservation are included on Idaho's 303(d) list for nutrients and sediments. Tt performed extensive data analysis to identify TSS and turbidity values representative of background, target and existing conditions for a variety of flow ranges. Using identified targets and an evaluation of the distribution of flow, Tt calculated loading capacities and necessary load reductions for the stream under different flow conditions. Tt is also developing TMDLs for nutrients and sediments for Fighting Creek, using Generalized Watershed Loading Function to simulate watershed loadings. Future TMDLs include sediment and nutrient TMDLs for Black Lake and Willow Creek. *July 2000 to Present*
Palma Risler EPA Region 9 Water Division San Francisco, CA (415) 972-3451	Tt is providing support for the development of a temperature TMDL for the North Fork Eel River. The temperature impairment is due in large part to disturbances in riparian zones that allow increased solar radiation to reach the waterbody and other geomorphic changes associated with increased sediment loads. The NF Eel is part of a consent decree settlement and EPA is developing the TMDL under a strict schedule. Tt is developing a GIS-based model that will estimate the heat load (from solar radiation) to the stream. The analysis will be compared to an interpretation of the state's narrative temperature standard that will include statistical analysis of available data. The analysis will compare existing riparian condition with site potential vegetation to determine load allocations. The structure of the model will allow CA and EPA to continue using the approach for other north coast waterbodies. *Dates: June 2003 to Present*

Reference Information	Description of Service
Thomas Henry TMDL Coordinator USEPA Region 3 Philadelphia, PA (215) 814-5752	In response to court-ordered schedules for TMDL establishment, Tt provided technical support to EPA Region 3 in the development of mining related TMDLs addressing metals impairments for the Tygart Valley River Watershed, West Virginia. The effort involved development of an innovative assessment and modeling technique, Mining Data Analysis System (MDAS), to address a variety of case-specific requirements related to water quality criteria, water use designations, source pollution conveyance methods, and permitting. Many of the impaired segments were small nested tributaries and had various water use designations that require specific acute and chronic numeric criteria. Over 300 permitted mining discharges, in multiple phases of reclamation (exhibiting various water quality conditions) were represented as point sources that simulated characteristics of precipitation driven discharges. Final TMDL allocations were assigned to more than 1,000 subwatersheds and over 80 individual mining facilities and resulted in the development of over 150 individual TMDLs for the watershed. Tt also provided technical support at public meetings and provided technical training to EPA Region 3 and its states. *Dates: October 1999 to March 2001*
Jeremy Sokulsky Water Resource Control Engineer Lahontan Regional Water Quality Control Board Lake Tahoe, CA 530-542-5463	Tt developed a copper TMDL for Haiwee Reservoir located in Inyo County, California. The primary source of copper to the reservoir is the application of copper sulfate to control algae within the reservoir system as well as the upstream portions of the Los Angeles aqueduct. The copper concentrations from these applications have resulted in fish kills in the reservoir, from either direct toxicity or reduced dissolved oxygen levels caused by algal decomposition. The availability of data to represent the hydrologic and water quality characteristics of the Haiwee Reservoir system provided an opportunity to develop a site-specific model that could be used as an assessment tool for the TMDL process as well as a management tool for the primary stakeholder. The Haiwee Reservoir Copper Model was developed using Mircosoft Excel as the platform and user interface. The model's computational scheme is comprised of three layered components, water balance, sediment budget, and copper mass balance. The resulting calibrated model is useful for testing various operational scenarios and performing loading-source and water quality analyses. *Dates: January 2001 to August 2001*
Kent Montague Utah DEQ Division of Water Quality Salt Lake City, UT (801) 538-6057	Tt has worked with the Virgin River Advisory Committee and Utah DWQ to develop a suite of TMDLs for the Virgin River watershed in southwest Utah. Extensive work was conducted as part of the TMDL to determine the most significant sources of TDS, nutrients, and selenium. An aerial photo survey was conducted as well as on-the-ground field surveys. The information used from these activities were fed into a series of spreadsheets to estimate pollutant sources. In addition to developing a Project Implementation Plan, conducting a use attainability analysis, developing a TMDL and a Surface Water Source Protection Plan, Tt is also developing a Watershed Management Plan for the Virgin River watershed. The Watershed Management Plan will include management and project recommendations that are responsive to key project issues. The Watershed Protection Plan will belong to the residents of the watershed and focus on issues including water rights, right-to-farm proposals, recreational needs, wetland protection, and property rights. *Dates: July 2002 to Present*

2.3.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including source assessment activities, to support TMDL development, to state, local, and federal agencies. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and 40 states. Our experience dates back to the opening of the Center for Water Resources office in 1976 but has significantly increased during the past 10 years as the TMDL program has expanded nationwide. All work has been performed under the company name Tetra Tech, Inc.

This section provides biosketches for the key personnel who will provide primary support in this service category. We have many other specialists with extensive TMDL experience that cannot be shown due to the 20-person limit specified in the RFP. Full resumes of all personnel described below are provided in Appendix A

Kirk Gregory (Project Manager)
Dr. Gregory is an environmental scientist with more than 9 years of experience in hydrologic modeling, geographic information systems (GIS), and remote sensing technologies for urban and agricultural watershed assessment and management. He uses hydrologic models coupled with GIS to assess the impacts of land use change on water quantity and quality. He also uses GIS-based models to examine sediment erosion processes from cultivation and construction activities. He has demonstrated an ability to deliver innovative solutions that encompass local, state, and federal water resource objectives and goals.

Andrew Parker
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Clary Barreto-Acobe
Ms. Barreto is a water resources/environmental engineer with four years of professional experience and two years of research experience in the areas of hydrodynamics, water quality modeling, sediment transport, coastal processes and groundwater hydrology. She has developed and applied computer models to simulate the fate and transport of pollutants in streams, lakes, estuaries and coastal regions. Her area of expertise is sediment-water interaction. Ms. Barreto is proficient in the use of ArcView GIS, Microsoft Access, Mining Data Analysis System (MDAS), Loading Simulation Program in C++ (LSPC), BASINS, HEC-HMS, HEC-RAS and MODFLOW. She has significant experience programming in C++, FORTRAN, and MATLAB. Ms. Barreto is also fluent in English and Spanish.

Clint Boschen
Mr. Boschen has more than seven years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He has supported Clean Water Act programs at the state and national level and is currently involved in TMDL development projects and biological assessment studies throughout the country. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. He routinely conducts watershed studies focusing on the assessment of biological condition in relation to pollutant levels and anthropogenic impacts. Mr. Boschen has experience in planning and conducting field monitoring studies, watershed characterization and modeling, wetland and stream corridor assessments, and water quality planning activities. His academic and research experience is in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Shad Bowman
Mr. Bowman has over 7 years of experience with various water resources issues involving Total Maximum Daily Loads (TMDLs), surface water quality standards, drinking water, and ecological studies. Mr. Bowman is familiar with ecosystems of the western United States, and has participated in several projects for TMDLS,

water quality standards, restoration projects, outreach, and policy development in regards to differing ecosystems. Mr. Bowman has served as a project manager for over 110 TMDLs that addressed various contaminants, stream reaches, and conditions. He has been directly involved in the development of over 200 total TMDLs. He has been involved in, and responsible for, all phases of the TMDL development process, from water quality standards review and development, to impairment assessments and determinations to delisting and TMDL creation, and implementation and restoration planning. In addition to TMDLs, Mr. Bowman has been involved in the development of surface water quality standards development, rule and policy development activities, sampling plan development, 303(d) and 305(b) assessments, data analysis, database development, and public meeting facilitation and outreach activities. Mr. Bowman has designed developed and presented several workshops, trainings, and presentations dealing with TMDLs, Implementation, Source Assessments, and Stream Restoration.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

John Craig
Mr. Craig is a water resources specialist with more than 14 years of experience evaluating watershed and water quality problems and providing support for federal, state, and local policy issues. His areas of expertise include watershed management, Total Maximum Daily Load (TMDL) development and training; water quality assessment; and risk assessment. Currently projects include management of a nutrient criteria pilot study in Montana and North Dakota; management of a nutrient assessment for the watersheds of Lake Elsinore, CA; management and technical support for the development of nutrient and pathogen TMDLs for the Los Angeles River; and management and development of a watershed management plan and TMDL for Pineview Reservoir, Utah. Mr. Craig currently serves as the director of Tt's Fairfax Water Resources department and has been providing ongoing management and technical support for local, state, and federal water programs in the south and west.

Scott Daly
Mr. Daly is an environmental scientist with 2 years experience in watershed management, biomonitoring, and data analysis. He is proficient in aqueous chemistry, hydrologic and geomorphic processes, and taxonomic identification of freshwater macroinvertebrates. In addition, Mr. Daly has knowledge of surface water, ground water, aquatic ecosystems, geology, and statistics. While at Slippery Rock University his course work consisted of Organic Chemistry, Earth Materials, Geomorphology, Ecology, Environmental Microbiology, Biometry, Hydrology, Freshwater Biomonitoring, and Water Quality Assessment. He is also proficient with Corel 9, MS Office, SAS, Arc View, BASINS, Spatial Analyst, 3D Analyst, Network Analyst, and additional GIS tools.

Mustafa Faizullabhoy
Mr. Faizullabhoy is a water resources/environmental engineer with more than 2 years of professional experience in the areas of water quality modeling, storm water management planning and design, hydrologic and hydraulic modeling, open/closed storm drain design and analysis, storm water sampling, and TMDL development. He has developed TMDLs for EPA Regions 3, 4, and 9 for a variety of pollutants and waterbody types. For the development of a copper TMDL for Haiwee Reservoir, CA, he supported the development of a model to simulate the sediment water column interaction for copper in the reservoir. Currently, Mr.

Faizullabhoy is supporting several EPA engineering and cost studies for BMPs associated with several agricultural industries. He is also providing support for the development of TMDLs for Newport Bay and the application of CE-QUAL-W2 for a modeling study for the Tongue River Reservoir in Montana.

Ana García

Dr. García has extensive experience in the mathematical modeling of fundamental physical phenomena, with an emphasis on watershed modeling. Her graduate work, both at the Master's and Ph.D levels, involved the development of new simulation models. She developed a simulation model to solve various environmental problem, including subsurface and channel flow in tile drained watersheds. She has published several academic articles in water resources as well as in mechanical engineering journals. At Tt, Dr. García has been the lead modeler for an extensive modeling study of the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana and northeastern Wyoming. She has also applied her expertise in agro-hydrology in the development of several TMDLs for US EPA Regions 4 and 5, Ohio EPA, Illinois EPA and Indiana Department of Environmental Management (IDEM). She also works on quality assurance issues as they pertain to the use of water quality and hydrologic models in TMDL development.

Jessica Koenig

Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Kevin Kratt

Mr. Kratt has more than eight years of experience in water resources analysis for point and nonpoint source pollution in both urban and agricultural areas. This experience includes watershed modeling, water quality analysis, selection of water quality targets, and evaluation of best management practices (BMPs). He has also been extensively involved in the national and local evaluation of TMDL development activities and in various point and nonpoint source policy issues. Mr. Kratt has been supporting EPA and various state agencies on the TMDL and related programs since 1995. He has provided technical and programmatic support to all phases of the TMDL program, from guidance development, technical reviews, and TMDL development, to national training and facilitation. His support has included review of numerous TMDLs, technical oversight for more than a hundred TMDL development projects throughout the United States, development of new TMDL course materials, development of the first TMDL protocols and modeling compendium, and recommendations on various 303(d) listing issues. He has responded to numerous quick response requests for technical review and consultation. Mr. Kratt is familiar with most of the loading and receiving water quality models used for TMDL development, including their strengths and weaknesses for various applications. Mr. Kratt has been supporting EPA and DEQ on Montana TMDL development activities for the past two years.

Yoichi Matsuzuru

Mr. Matsuzuru is an environmental scientist with 6 years of professional experience in Water Resource field. The experiences include developing the Total Maximum Daily Load (TMDL) Program under Clean Water Act section 303(d) in South Carolina, West Virginia, Arizona, and Florida state government. He also has a field research experience in assessing biogeochemical cycles in subsurface and surface water at the Southeastern Tree Research and Education Site Project in North Carolina. He has a programming skill in FORTRAN and other computer languages. He is currently the task leader for the technical support and development of South Carolina's pathogens TMDLs.

Teresa Rafi
Ms. Rafi has more than 7 years of professional experience in public sector environmental science and policy. She has supported numerous aspects of the Coastal Zone Management and Clean Water Acts at both the state and national levels, performing public outreach, interagency coordination, and conflict resolution. She has been a member of the Water Resources Group at Tt, since October 2000, where her activities include TMDL development for fecal coliform and metals-impaired waterbodies, curriculum development for watershed modeling courses, and database development in support of numerous EPA programmatic initiatives. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques, developing strategies for and conducting public outreach initiatives, meeting facilitation, and development of management indicators for gauging program performance.

John Riverson
Mr. Riverson is a water resources engineer with five years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He also has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. He has published engineering and business instructional material for the Darden School of Business Administration (University of Virginia), and has played a supporting role in providing technical analysis, narratives, schematics diagrams, and technical figures for two engineering textbooks and various peer-reviewed technical papers. Mr. Riverson has worked on a variety of projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several state and county water resource operatives, and the US Army Corps of Engineers.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt's Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

Nancy Sullins
Ms. Sullins has 20 years of project management experience with over 9 years of experience concentrated in regulatory water quality issues. This experience includes receiving water modeling (QUAL2E, WASP, WQMap, BRANCH/BLTM, EFDC, CE-QUAL-W2, CORMIX, STELLA and CWQM), water shed modeling (LSPC, GWLF), water quality analysis, selection of water quality targets, standards interpretation, water quality evaluations for Environmental Impact Assessments and Environmental Impact Statements as well as NPDES permit limit development. She has also been involved in various point and nonpoint source policy issues such as nutrient load trading and atmospheric deposition. She is experienced in the application of dynamic multi-dimensional water quality models used to determine TMDLs and NPDES permit limits in fresh water and estuarine systems. She has been actively involved in several projects focusing on water quality standards and

methodology development.

Julie Tsatsaros
Ms. Tsatsaros is a Senior Environmental Scientist with ten years experience in the environmental field focusing on all aspects of surface water quality, watershed, and assessments and studies. Ms. Tsatsaros has over five years of Total Maximum Daily Load (TMDL) experience. She has an extensive background in designing, implementing, and conducting fieldwork and sampling. She also has a strong laboratory background. Ms. Tsatsaros has experience consulting with State/Tribal/Federal agencies, as well as research oriented studies. A former employee of the New Mexico Environment Department (NMED), she is familiar with western water quality issues, and the complex issues found in this region.

2.3.3 Method of Providing Services and Quality Assurance

Our work in determining load allocations in the Flathead Lake watershed in Montana offers a good example of the methodology we will use to complete projects in this service category. This project has several distinct phases. Phase I involved a review of previous studies, existing models, and a technical approach recommendation. Phase II involved model construction, calibration and verification. Phase III will center around model documentation, reporting and training. Phase IV will focus on scenario development and application.

In Phase I of this project, we first reviewed previous large lake modeling studies that addressed loading from both nonpoint and point sources. Next, we performed a review of existing watershed loading models to evaluate the current state-of-the-art in large-scale watershed loading modeling approaches. Lastly, DEQ was provided with documentation concerning model recommendations. This information allowed DEQ to select an appropriate model to use for the Flathead Lake watershed as well as to develop a project timeline and budget estimates. The model selected by DEQ for this project is the Soil Water Assessment Tool (SWAT). SWAT is an effective modeling tool for assessing nonpoint sources of sediment and nutrients in large watersheds.

In Phase II (model construction) we first obtained all available spatial and tabular data required by SWAT. Data layers covering the entire watershed include 30meter digital elevation data, STATSGO soils, the most recent MRLC land use and land cover data, National Hydrography Database stream layers, meteorological stations, NRCS SNOTEL locations, and water flow and water quality monitoring sites. In consultation with DEQ, 5th Code Level subbasins were used as a guide for all subbasin delineation in the Flathead Lake watershed. We have worked closely with DEQ to correctly delineate subbasin areas such that critical land uses are adequately characterized in the watershed model. We also compiled and analyzed available flow and water quality data to establish boundary conditions and, in consultation with DEQ, establish calibration points for the model.

Since snowmelt is such an important factor governing flows and loadings in the basin, we selected a small alpine creek in the North Fork Subbasin of the Flathead River Basin to evaluate SWAT's snowmelt capabilities. Cooperative precipitation and temperature data, as well as available SNOTEL data were used in this modeling effort. A comparison of modeled versus observed flow, including statistical descriptors, were forwarded to MDEQ. The comparison showed that SWAT did not adequately simulate snowmelt processes in these high-elevation mountain watersheds. Consequently, after discussions with Tt, DEQ has requested that SWAT model developers make improvements in the snowmelt routine. This will be a very beneficial improvement to the model and to the watershed management efforts of DEQ.

Upon completion of Phase II, a report describing all data sources used in the SWAT modeling, along with a list and description of model input parameters, and complete description of model calibration and verification results, including statistical descriptors, for all subbasins will be forwarded to DEQ for its review and comment. DEQ must approve all activities in Phase II before work on Phase III may begin.

Phase III of the project will provide DEQ with a report documenting the SWAT model, its GIS interface, and its application to the Flathead River watershed. Additionally, Tt will provide SWAT training to all relevant personnel at DEQ. Work completed under Phase III of the project must be approved by DEQ before proceeding to Phase IV.

Phase IV of the project will involve the development of various land use/land cover changes in the Flathead River watershed, and the potential consequences of those changes on water quantity and water quality. DEQ will provide the change scenarios, which may include a combination of land use change and/or changes in forest cover due to harvest or fire. After close consultation with DEQ changes in the SWAT input file will be made to reflect the desired scenarios. Finally a full report outlining the scenarios and description of the model results will be forwarded to MDEQ for its review and comment.

2.3.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Dr. Kirk Gregory, is provided above.

Table 2-7. Staff qualifications for service category 3.5.6: (TMDL Load Allocations).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74
Clary Barreto-Acobe	M.S.	Environmental Engineering	Yes	4/4	47.20
Clint Boschen	M.S.	Biological Sciences	Yes	7/7	101.72
Shad Bowman	B.S.	Physics/Environmental Biology	Yes	7/7	84.64
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
John Craig	M.S.	Marine, Estuarine, and Environmental Science	Yes	14/14	154.51
Scott Daly	B.S.	Environmental Science	Yes	2/2	51.05
Mustafa Faizullabhoy	M.S.	Civil/Environmental Engineering	Yes	4/4	81.58
Ana Garcia	Ph.D.	Agricultural Engineering	Yes	5/5	88.67
Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Kevin Kratt	M.S.	Water Resources	Yes	8/8	121.24
Yoichi Matsuzuru	M.S.	Water Resources	Yes	4/4	87.72
Teresa Rafi	B.A.	Environmental Science	Yes	7/7	87.86
John Riverson	M.S.	Civil/Environmental Engineering	Yes	5/5	104.79
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
Nancy Sullins	M.P.H.	Environmental Quality	Yes	20/20	102.50
Julie Tsatsaros	M.S.	Limnology	Yes	10/10	92.13

2.4 Service Category 3.5.7: Total Maximum Daily Loads

Since the early 1980s, Tt staff have supported states and EPA in implementing their TMDL programs through such activities as developing guidance documents; conducting pilot studies; developing cost-effective modeling strategies for simple to complex waterbodies (rivers, reservoirs, estuaries) and complex source-pollutant types; providing modeling and TMDL development training; as well as actually developing thousands of TMDLs. We have also successfully responded to TMDL development under stringent court-mandated schedules. We competently perform all aspects of the TMDL development process, including calculating TMDLs; assembling, managing, and interpreting available data; determining appropriate water quality endpoints/targets; collecting and assessing new data, when necessary; conducting watershed and water quality modeling; identifying and characterizing point and nonpoint sources; identifying controls for point and nonpoint source pollutant loads to receiving waters; establishing monitoring plans to assess whether the controls that are implemented are actually working; and participating in public outreach and education to answer questions and concerns about the watershed studies. Staff are currently working on the development of numerous TMDLs nationwide, including finalizing TMDLs for the Dearborn River, Lake Helena, Tongue River, Powder River, Rosebud Creek, Flathead Headwaters, and Lake Mary Ronan watersheds in Montana.

2.4.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references. Please note that Tt has completed more than 2,000 TMDLs nationwide over the past ten years and therefore the table below represents only a very small subset of our work in this area. Multiple TMDL projects have been completed for most of the references in the table shown below.

Table 2-8. Summary of references for Service Category 3.5.7: Total Maximum Daily Loads.

Reference Information	Description of Service
Art Compton Montana Department of Environmental Quality Planning, Prevention & Assistance Division (406) 444-6754	Tt is providing TMDL development support to the Montana Department of Environmental Quality and USEPA Region 8 for the Tongue River, Powder River, and Rosebud Creek basins in Montana and Wyoming. A court order coupled with industry pressure to drill for coalbed methane in the basins has accelerated the TMDL development schedule and added to the high profile nature of this project. Tt has compiled several thousand water quality observations from a variety of sources (MDEQ, WDEQ, USGS, stakeholders, universities, the Northern Cheyenne Tribe) and prepared detailed reviews of the impairment status of the listed streams. Pollutants include metals, siltation, TDS, nutrients, pathogens, and dissolved oxygen. =Tt is now in the process of developing and applying a variety of spreadsheet and dynamic modeling tools to evaluate the potential impact of CBM produced water on downstream surface and groundwater. The results of the analysis will be used to meet a variety of Clean Water Act provisions, such as water quality standards, NPDES, and TMDL requirements. *Dates: April 2002 to Present*
Ron Steg USEPA Region 8 Montana Operations Office Helena, MT (406) 457-5024	For EPA Montana Operations Office, Tt is working closely with Land and Water Consulting to develop sediment, nutrient, and metal TMDLs for the Lake Helena watershed. Tt first compiled all available data and information for the watershed to determine the impairment status for all 1996 listed waters. Because sufficient data were not available for some waters, a Sampling and Analysis Program was initiated during the summer of 2003. Land and Water Consulting, with Tt assistance, also conducted a source assessment as part of the field activities. Once additional data were available, Tt researched appropriate nutrient criteria for the watershed by speaking to DEQ and other nutrient experts. A dynamic watershed model has also been setup and calibrated to develop the metals and nutrient TMDLs. Tt helped present the results of the sampling and impairment analysis activities at a recent Technical Advisory Committee meeting and will work with the TAC as the TMDLs are finalized during the summer and fall of 2004. *Dates: October 2002 to Present*
Dave Montali TMDL Coordinator West Virginia Department of Environmental Protection Charleston, WV (304) 558-2837	Tt staff are currently supporting the development of biological TMDLs for impaired streams in the Upper Ohio, Upper Kanawha, Lower Kanawha, Coal River, and North Branch Potomac watersheds in West Virginia. Statistical techniques were used to examine stressor-biological response relationships, including the development of novel diagnostic tools that utilize biological data to help identify and rank potential benthic community stressors. A reference watershed approach was used to define regional and site-specific TMDL endpoints for identified stressors (pollutants). Impaired and reference watersheds were modeled using MDAS and GWLF to determine the conditions necessary to support a healthy benthic community. TMDLs are currently being developed (or have been developed) to address excessive sedimentation, metals contamination, acidity, and other problems that have been linked to observed biological impacts. *Dates:*

	October 2002 to Present
Dave Smith USEPA Region 9 TMDL Team Leader San Francisco, CA (415) 972-3416	For EPA Region 9, our staff has supported the development of over 10 sediment TMDLs for watersheds in northern CA. Only narrative criteria exist for sediment. Tt staff worked with EPA and the state to conduct reviews of available data from pre- and post-harvest sites and developed an inventory of possible reference sites. This process was complicated by the need to address the geologic instability associated with the region and the relatively large natural erosion and mass wasting rates. A final suite of indicators was developed and targets were established for the TMDL. *Dates: October 1995 to Present*
Jayne Carlin TMDL Specialist USEPA Region 10 1200 Sixth Avenue Seattle, WA (206) 553-8512	Several waterbodies within the Coeur d'Alene reservation are included on Idaho's 303(d) list for nutrients and sediments. Tt performed extensive data analysis to identify TSS and turbidity values representative of background, target and existing conditions for a variety of flow ranges. Using identified targets and an evaluation of the distribution of flow, Tt calculated loading capacities and necessary load reductions for the stream under different flow conditions. Tt is also developing TMDLs for nutrients and sediments for Fighting Creek, using Generalized Watershed Loading Function to simulate watershed loadings. Future TMDLs include sediment and nutrient TMDLs for Black Lake and Willow Creek. *Dates: July 2000 to Present*
Palma Risler EPA Region 9 Water Division San Francisco, CA (415) 972-3451	Tt is providing support for the development of a temperature TMDL for the North Fork Eel River. The temperature impairment is due in large part to disturbances in riparian zones that allow increased solar radiation to reach the waterbody and other geomorphic changes associated with increased sediment loads. The NF Eel is part of a consent decree settlement and EPA is developing the TMDL under a strict schedule. Tt is developing a GIS-based model that will estimate the heat load (from solar radiation) to the stream. The analysis will be compared to an interpretation of the state's narrative temperature standard that will include statistical analysis of available data. The analysis will compare existing riparian condition with site potential vegetation to determine load allocations. The structure of the model will allow CA and EPA to continue using the approach for other north coast waterbodies. *Dates: May 2002 to June 2003*
Thomas Henry TMDL Coordinator USEPA Region 3 Philadelphia, PA (215) 814-5752	In response to court-ordered schedules for TMDL establishment, Tt provided technical support to EPA Region 3 in the development of mining related TMDLs addressing metals impairments for the Tygart Valley River Watershed, West Virginia. The effort involved development of an innovative assessment and modeling technique, Mining Data Analysis System (MDAS), to address a variety of case-specific requirements related to water quality criteria, water use designations, source pollution conveyance methods, and permitting. Many of the impaired segments were small nested tributaries and had various water use designations that require specific acute and chronic numeric criteria. Over 300 permitted mining discharges, in multiple phases of reclamation (exhibiting various water quality conditions) were represented as point sources that simulated characteristics of precipitation driven discharges. Final TMDL allocations were assigned to more than 1,000 subwatersheds and over 80 individual mining facilities and resulted in the development of over 150 individual TMDLs for the watershed. Tt also provided technical support at public meetings and provided technical training to EPA Region 3 and its states. *Dates: October 1999 to March 2001*
Vern Berry TMDL Assistant U.S. EPA Region 8 Denver, CO (303) 312-6234	Tt assisted U.S. EPA Region 8 and the North Dakota Division of Water Quality in the development of nutrient and sediment TMDLs for the Heart River, Patterson Lake, and Rice Lake in North Dakota. The state had already prepared Clean Lake Diagnostic/Feasibility studies and elements of these reports were used to develop the TMDLs. Tt reviewed available data and, in collaboration with the state and Region 8, provided recommendations for TMDL targets, source reduction needs, and best management practices. *Dates: October 2001 to September 2002.*

Jeremy Sokulsky Water Resource Control Engineer Lahontan Regional Water Quality Control Board Lake Tahoe, CA (530) 542-5463	Tt developed a copper TMDL for Haiwee Reservoir located in Inyo County, California. The primary source of copper to the reservoir is the application of copper sulfate to control algae within the reservoir system as well as the upstream portions of the Los Angeles aqueduct. The copper concentrations from these applications have resulted in fish kills in the reservoir, from either direct toxicity or reduced dissolved oxygen levels caused by algal decomposition. The availability of data to represent the hydrologic and water quality characteristics of the Haiwee Reservoir system provided an opportunity to develop a site-specific model that could be used as an assessment tool for the TMDL process as well as a management tool for the primary stakeholder. The Haiwee Reservoir Copper Model was developed using Mircosoft Excel as the platform and user interface. The model's computational scheme is comprised of three layered components, water balance, sediment budget, and copper mass balance. The resulting calibrated model is useful for testing various operational scenarios and performing loading-source and water quality analyses. *Dates: January 2001 to August 2001*
Kent Montague Utah DEQ Division of Water Quality Salt Lake City, UT (801) 538-6057	Tt has worked with the Virgin River Advisory Committee and Utah DWQ to develop a suite of TMDLs for the Virgin River watershed in southwest Utah. In addition to developing a Project Implementation Plan, conducting a use attainability analysis, developing a TMDL and a Surface Water Source Protection Plan, Tt is also developing a Watershed Management Plan for the Virgin River watershed. The Watershed Management Plan will include management and project recommendations that are responsive to key project issues. The Watershed Protection Plan will belong to the residents of the watershed and focus on issues including water rights, right-to-farm proposals, recreational needs, wetland protection, and property rights. *Dates: July 2002 to Present*
Staci Goodwin Indiana Department of Environmental Management Office of Water Quality (317) 234-3311	Tt developed an *E. coli* TMDL for the Lake Michigan shoreline for the Indiana Department of Environmental Management. The project included multiple phases including: data compilation, data analysis, methodology selection, detailed watershed and water quality modeling, preparation of TMDL documents and implementation plans, and public involvement. Tt gathered and analyzed all available water quality data and assessed the data for spatial and temporal trends and comparison to the standard. Tt then applied the three-dimensional Environmental Fluid Dynamics Code (EFDC) model to evaluate the effects of wind, waves, tributary loadings, and other factors on *E. coli* concentrations along the near shore. The draft TMDL report was submitted to IDEM in February 2004 and is scheduled to be finalized in June 2004. *Dates: June 2002 to Present*

2.4.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including TMDLs, to state, local, and federal agencies. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and 40 states. Our experience dates back to the opening of the Center for Water Resources office in 1976 but has significantly increased during the past 10 years as the TMDL program has expanded nationwide. All work has been performed under the company name Tetra Tech, Inc.

This section provides biosketches for the key personnel who will provide primary support in this service category. We have many other specialists with extensive TMDL experience that cannot be shown due to the 20-person limit specified in the RFP. Full resumes of all personnel described below are provided in Appendix A

Kevin Kratt (Project Manager)
Mr. Kratt has more than eight years of experience in water resources analysis for point and nonpoint source pollution in both urban and agricultural areas. This experience includes watershed modeling, water quality analysis, selection of water quality targets, and evaluation of best management practices (BMPs). He has also been extensively involved in the national and local evaluation of TMDL development activities and in various point and nonpoint source policy issues. Mr. Kratt has been supporting EPA and various state agencies on the TMDL and related programs since 1995. He has provided technical and programmatic support to all phases of

the TMDL program, from guidance development, technical reviews, and TMDL development, to national training and facilitation. His support has included review of numerous TMDLs, technical oversight for more than a hundred TMDL development projects throughout the United States, development of new TMDL course materials, development of the first TMDL protocols and modeling compendium, and recommendations on various 303(d) listing issues. He has responded to numerous quick response requests for technical review and consultation. Mr. Kratt is familiar with most of the loading and receiving water quality models used for TMDL development, including their strengths and weaknesses for various applications. Mr. Kratt has been supporting EPA and DEQ on Montana TMDL development activities for the past two years.

Andrew Parker
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Clary Barreto-Acobe
Ms. Barreto is a water resources/environmental engineer with four years of professional experience and two years of research experience in the areas of hydrodynamics, water quality modeling, sediment transport, coastal processes and groundwater hydrology. She has developed and applied computer models to simulate the fate and transport of pollutants in streams, lakes, estuaries and coastal regions. Her area of expertise is sediment-water interaction. Ms. Barreto is proficient in the use of ArcView GIS, Microsoft Access, Mining Data Analysis System (MDAS), Loading Simulation Program in C++ (LSPC), BASINS, HEC-HMS, HEC-RAS and MODFLOW. She has significant experience programming in C++, FORTRAN, and MATLAB. Ms. Barreto is also fluent in English and Spanish.

Clint Boschen
Mr. Boschen has more than seven years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He has supported Clean Water Act programs at the state and national level and is currently involved in TMDL development projects and biological assessment studies throughout the country. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. He routinely conducts watershed studies focusing on the assessment of biological condition in relation to pollutant levels and anthropogenic impacts. Mr. Boschen has experience in planning and conducting field monitoring studies, watershed characterization and modeling, wetland and stream corridor assessments, and water quality planning activities. His academic and research experience is in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Shad Bowman
Mr. Bowman has over 7 years of experience with various water resources issues involving Total Maximum Daily Loads (TMDLs), surface water quality standards, drinking water, and ecological studies. Mr. Bowman is familiar with ecosystems of the western United States, and has participated in several projects for TMDLS, water quality standards, restoration projects, outreach, and policy development in regards to differing ecosystems. Mr. Bowman has served as a project manager for over 110 TMDLs that addressed various contaminants, stream reaches, and conditions. He has been directly involved in the development of over 200

total TMDLs. He has been involved in, and responsible for, all phases of the TMDL development process, from water quality standards review and development, to impairment assessments and determinations to delisting and TMDL creation, and implementation and restoration planning. In addition to TMDLs, Mr. Bowman has been involved in the development of surface water quality standards development, rule and policy development activities, sampling plan development, 303(d) and 305(b) assessments, data analysis, database development, and public meeting facilitation and outreach activities. Mr. Bowman has designed developed and presented several workshops, trainings, and presentations dealing with TMDLs, Implementation, Source Assessments, and Stream Restoration.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

John Craig
Mr. Craig is a water resources specialist with more than 14 years of experience evaluating watershed and water quality problems and providing support for federal, state, and local policy issues. His areas of expertise include watershed management, Total Maximum Daily Load (TMDL) development and training; water quality assessment; and risk assessment. Currently projects include management of a nutrient criteria pilot study in Montana and North Dakota; management of a nutrient assessment for the watersheds of Lake Elsinore, CA; management and technical support for the development of nutrient and pathogen TMDLs for the Los Angeles River; and management and development of a watershed management plan and TMDL for Pineview Reservoir, Utah. Mr. Craig currently serves as the director of Tt's Fairfax Water Resources department and has been providing ongoing management and technical support for local, state, and federal water programs in the south and west.

Scott Daly
Mr. Daly is an environmental scientist with 2 years experience in watershed management, biomonitoring, and data analysis. He is proficient in aqueous chemistry, hydrologic and geomorphic processes, and taxonomic identification of freshwater macroinvertebrates. In addition, Mr. Daly has knowledge of surface water, ground water, aquatic ecosystems, geology, and statistics. While at Slippery Rock University his course work consisted of Organic Chemistry, Earth Materials, Geomorphology, Ecology, Environmental Microbiology, Biometry, Hydrology, Freshwater Biomonitoring, and Water Quality Assessment. He is also proficient with Corel 9, MS Office, SAS, Arc View, BASINS, Spatial Analyst, 3D Analyst, Network Analyst, and additional GIS tools.

Mustafa Faizullabhoy
Mr. Faizullabhoy is a water resources/environmental engineer with more than 2 years of professional experience in the areas of water quality modeling, storm water management planning and design, hydrologic and hydraulic modeling, open/closed storm drain design and analysis, storm water sampling, and TMDL development. He has developed TMDLs for EPA Regions 3, 4, and 9 for a variety of pollutants and waterbody types. For the development of a copper TMDL for Haiwee Reservoir, CA, he supported the development of a model to simulate the sediment water column interaction for copper in the reservoir. Currently, Mr. Faizullabhoy is supporting several EPA engineering and cost studies for BMPs associated with several agricultural industries. He is also providing support for the development of TMDLs for Newport Bay and the application of CE-QUAL-W2 for a modeling study for the Tongue River Reservoir in Montana.

Ana García
Dr. García has extensive experience in the mathematical modeling of fundamental physical phenomena, with an emphasis on watershed modeling. Her graduate work, both at the Master's and Ph.D levels, involved the development of new simulation models. She developed a simulation model to solve various environmental problem, including subsurface and channel flow in tile drained watersheds. She has published several academic articles in water resources as well as in mechanical engineering journals. At Tt, Dr. García has been the lead modeler for an extensive modeling study of the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana and northeastern Wyoming. She has also applied her expertise in agro-hydrology in the development of several TMDLs for US EPA Regions 4 and 5, Ohio EPA, Illinois EPA and Indiana Department of Environmental Management (IDEM). She also works on quality assurance issues as they pertain to the use of water quality and hydrologic models in TMDL development.

Jessica Koenig
Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Yoichi Matsuzuru
Mr. Matsuzuru is an environmental scientist with 6 years of professional experience in Water Resource field. The experiences include developing the Total Maximum Daily Load (TMDL) Program under Clean Water Act section 303(d) in South Carolina, West Virginia, Arizona, and Florida state government. He also has a field research experience in assessing biogeochemical cycles in subsurface and surface water at the Southeastern Tree Research and Education Site Project in North Carolina. He has a programming skill in FORTRAN and other computer languages. He is currently the task leader for the technical support and development of South Carolina's pathogens TMDLs.

Teresa Rafi
Ms. Rafi has more than 7 years of professional experience in public sector environmental science and policy. She has supported numerous aspects of the Coastal Zone Management and Clean Water Acts at both the state and national levels, performing public outreach, interagency coordination, and conflict resolution. She has been a member of the Water Resources Group at Tt, since October 2000, where her activities include TMDL development for fecal coliform and metals-impaired waterbodies, curriculum development for watershed modeling courses, and database development in support of numerous EPA programmatic initiatives. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques, developing strategies for and conducting public outreach initiatives, meeting facilitation, and development of management indicators for gauging program performance.

John Riverson
Mr. Riverson is a water resources engineer with five years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He also has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. He has published engineering and business instructional material for the Darden School of Business Administration (University of Virginia), and has played a supporting role in providing technical analysis, narratives, schematics diagrams, and technical figures for two engineering textbooks and various peer-reviewed technical papers. Mr. Riverson has worked on a variety of projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several

state and county water resource operatives, and the US Army Corps of Engineers.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt's Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

Nancy Sullins
Ms. Sullins has 20 years of project management experience with over 9 years of experience concentrated in regulatory water quality issues. This experience includes receiving water modeling (QUAL2E, WASP, WQMap, BRANCH/BLTM, EFDC, CE-QUAL-W2, CORMIX, STELLA and CWQM), water shed modeling (LSPC, GWLF), water quality analysis, selection of water quality targets, standards interpretation, water quality evaluations for Environmental Impact Assessments and Environmental Impact Statements as well as NPDES permit limit development. She has also been involved in various point and nonpoint source policy issues such as nutrient load trading and atmospheric deposition. She is experienced in the application of dynamic multi-dimensional water quality models used to determine TMDLs and NPDES permit limits in fresh water and estuarine systems. She has been actively involved in several projects focusing on water quality standards and methodology development.

Julie Tsatsaros
Ms. Tsatsaros is a Senior Environmental Scientist with ten years experience in the environmental field focusing on all aspects of surface water quality, watershed, and assessments and studies. Ms. Tsatsaros has over five years of Total Maximum Daily Load (TMDL) experience. She has an extensive background in designing, implementing, and conducting fieldwork and sampling. She also has a strong laboratory background. Ms. Tsatsaros has experience consulting with State/Tribal/Federal agencies, as well as research oriented studies. A former employee of the New Mexico Environment Department (NMED), she is familiar with western water quality issues, and the complex issues found in this region.

2.4.3 Method of Providing Services and Quality Assurance

Tt's ongoing TMDL development project for the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana illustrates our basic approach toward TMDL development. This project is being implemented in three phases. Phase I consisted of conducting a watershed characterization to assess the physical, chemical, and biological characteristics of the surrounding watershed. The purpose of this task was to produce a document and supporting data to describe the current physical, chemical, and biological condition of the environment within the subject watersheds. Landscape scale factors that were considered included: soils, climate, topography, land use, irrigation practices, vegetative cover, and riparian characteristics/condition. Hydrogeographic factors that were considered included: basic drainage patterns, the relationship between groundwater and surface water, water withdrawals, diversions, dams, irrigation returns, etc. Finally, the physical, chemical, and biological characteristics of the waterbodies themselves were described. The results of these tasks were summarized in three separate reports (one for each watershed) that were finalized and widely distributed in March 2003.

Because incomplete data were available to finalize many of the impairment decisions, Phase II of the project involved collecting additional data. A Quality Assurance Project Plan (QAPP) was prepared and approved by EPA and extensive sampling was conducted during the summer of 2003. Chemical, biological, and physical data were collected at a variety of sites over a period of several months.

Phase III of the project is ongoing and has consisted of the following tasks:

Develop Water Quality Targets

A water quality restoration target ("target") is a measurable value determined for the pollutant of concern that, if achieved, is expected to result in the attainment of water quality standards. Targets are required for all waterbody/pollutant combinations listed on the Montana 1996 List of Impaired Waters. Some targets for pollutants in the three watersheds are available as numeric criteria in state water quality standards (e.g., for electrical conductivity and sodium adsorption ratio (SAR)) but a question remains regarding whether these values appropriately take into account natural conditions. Targets for some other pollutants, such as nutrients, still must be identified. Tt is employing a weight-of-evidence approach that considers the results of sampling, modeling, and best professional judgment in determining appropriate targets and is using the results of approach to finalize impairment decisions.

Pollutant Source Assessment

The purpose of this task is to characterize the types, magnitudes, and locations of pollutant sources contributing a significant pollutant load to the waterbodies of concern. For each pollutant identified in the water quality impairment status report, Tt has compiled an inventory of all potential sources. Sources have been identified through assessment of maps, aerial photography, satellite imagery, monitoring data, assessment reports, and field surveys. Monitoring, statistical analysis, and modeling have all been used to determine the relative magnitude of source loadings, focusing on the primary and controllable sources. Both point and nonpoint sources have been considered, including the numerous coalbed methane wells that have recently been drilled in the Wyoming portion of the Tongue and Powder River watersheds. Tt has worked closely with Wyoming DEQ to ensure that accurate information on the coalbed methane wells is available.

Develop Total Maximum Daily Loads

Tt will support DEQ and EPA in the development of TMDLs to address each of the waterbody/pollutant combinations defined in the water quality impairment status report. To develop TMDLs it will be necessary to first estimate or measure current loads in the subject waterbodies. A dynamic watershed model is being used to assist in this process and the model development has proceeded in coordination with a Modeling Advisory Committee. The TMDLs will then be defined as the maximum load that would not result in exceeding the selected water quality restoration target (mass per time) with a built in allowance for margin of safety. If expressed as a percent reduction, the TMDL will be equivalent to the difference between the current load and the load that represents achievement of the water quality restoration target.

Allocations

Tt will use the loading capacity defined above to develop recommendations for the allocation of loads among all sources defined above. The allocation will take into account uncertainties associated with the analysis (the margin of safety) and might also include a reserve for future sources (such as new coalbed methane outfalls). Tt will work in coordination with DEQ, EPA and the stakeholders to decide upon an appropriate allocation approach. Three basic methods exist:

- Maximum Allowable Loads - Specific allocation of maximum allowable loads to specific source categories.

- Percentage Reduction Targets - Define the allocation in terms of specific percent load reductions for each of the significant sources.
- Performance Based - Express the allocation in terms of project performance expectations associated with management practices, which as a group, add up to meet overall load reduction goals.

Develop a Restoration Strategy That Includes Measures to Meet TMDL Targets and Allocations

Tt will support DEQ and EPA in developing a restoration strategy with sufficient detail to demonstrate that, when implemented, the proposed TMDLs would likely achieve full support of all applicable water quality standards. To meet DEQ/EPA requirements, the strategy will include coordination with stakeholders, prioritization of restoration needs, an allocation of restoration responsibilities, a restoration schedule and a monitoring plan to verify success.

Develop a Monitoring Strategy to Evaluate the Success of Restoration Measures

Tt will develop a water quality monitoring strategy that integrates ongoing efforts and complements, to the extent practicable, past efforts. The intent of the monitoring strategy will be to: 1) document water quality trends; 2) verify whether or not the water quality restoration targets have been met, and 3) provide a feed-back loop if the water quality targets are not met. The monitoring strategy should address the relationships between the monitoring plan and the water quality restoration targets, TMDL, source assessment, and proposed restoration measures. Site selection, sampling and analysis methods, and quality assurance/quality control practices will be detailed.

Finalize the Water Quality Restoration Plan

The Water Quality Restoration Plan will be summarized in a legally defensible document that includes:

- a clear statement of the water quality impairments;
- an assessment of existing conditions as they relate to impairments;
- a detailed, quantified source assessment;
- definition of quantifiable water quality goals and a measurable means to achieve the goals;
- a restoration plan, and;
- a monitoring plan to verify that the selected targets or interim benchmarks have been met.

2.4.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Mr. Kevin Kratt, is provided above.

Table 2-9. Staff qualifications for service category 3.5.7 (Total Maximum Daily Loads).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Clary Barreto-Acobe	M.S.	Environmental Engineering	Yes	4/4	47.20
Clint Boschen	M.S.	Biological Sciences	Yes	7/7	101.72
Shad Bowman	B.S.	Physics/Environmental Biology	Yes	7/7	84.64
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
John Craig	M.S.	Marine, Estuarine, and Environmental Science	Yes	14/14	154.51
Scott Daly	B.S.	Environmental Science	Yes	2/2	51.05
Mustafa Faizullabhoy	M.S.	Civil/Environmental Engineering	Yes	4/4	81.58

Ana Garcia	Ph.D.	Agricultural Engineering	Yes	5/5	88.67
Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Kevin Kratt	M.S.	Water Resources	Yes	8/8	121.24
Yoichi Matsuzuru	M.S.	Water Resources	Yes	4/4	87.72
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74
Teresa Rafi	B.A.	Environmental Science	Yes	7/7	87.86
John Riverson	M.S.	Civil/Environmental Engineering	Yes	5/5	104.79
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
Nancy Sullins	M.P.H.	Environmental Quality	Yes	20/20	102.50
Julie Tsatsaros	M.S.	Limnology	Yes	10/10	92.13

2.5 Service Category 3.5.10: Geographic Information Systems (GIS) Services

Tt’s Fairfax Group is nationally recognized for integrating advanced information management tools to support watershed planning, monitoring, assessment, and modeling. We have used the full extent of today's Information Technologies (IT) to successfully address challenging scientific and engineering analyses that would be difficult or impossible to address using traditional approaches. This has been accomplished because of our continuous strategic planning to enhance client support and by leveraging existing information and resources, intellectual capital, and technological investments. Unlike many other firms, Tt’s planners, scientists, and engineers themselves possess an advanced level of knowledge and understanding of database management and GIS technology which greatly complements our specialized IT staff in delivering products and services in a timely and cost-effective manner. This team of planners, scientists, engineers, and IT specialists work side by side to:

- Design, assemble and develop simple to complex databases (both spatial and tabular) to support data collection, monitoring, and modeling.
- Design and develop desktop solutions that involve integration of databases, GIS, assessment tools, and computational models.
- Develop client-server systems and Internet solutions for public access or presentation of highly processed information and services (e.g. assessment tools).

2.5.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references.

Table 2-10. Summary of references for Service Category 3.5.10: Geographic Information Services.

Reference Information	Description of Service
Bruce Yurdin Illinois EPA Sprinfield, IL (217) 782-3362	Tt developed the Nonpoint Source Modeling and TMDL Toolkit for the Illinois Environmental Protection Agency. The Toolkit consists of the Generalized Watershed Loading Function (GWLF) watershed model linked to an Excel spreadsheet that allows for easy calculation of TMDLs and evaluation of different management options. The purpose of the tool is to allow users to evaluate loadings of nutrients and sediments in watersheds impacted primarily by nonpoint sources for TMDL development or general watershed management purposes. A master database was prepared that contains all of the information that is necessary to run GWLF for any 14-digit watershed within the state (minus heavily urbanized and karst topography areas where GWLF would not be appropriate). This database contains both spatial and tabular data. The spatial data are in ArcView shape file format and contain the Illinois identification numbers for each 14-digit HUC, impaired streams included on the Illinois 303(d) list, and the

	appropriate weather file for each HUC. The tabular database is organized according to the 14-digit HUC identification number for the State of Illinois, although it is understood that the State is transitioning to smaller 12-digit watersheds for environmental analysis. Spatial and tabular data, including topographic, land use and land cover, soil units and characteristics, and weather station locations, were processed to provide model input parameters for each land use contained within each 14-digit watershed. Specifically, these parameters include land use type and area; the SCS curve number, and the product of the *KLSCP* variables of the Universal Soil Loss Equation. *Dates: June 2002 to July 2003*
Ron Steg USEPA Region 8 Montana Operations Office Helena, MT (406) 457-5024	For USEPA Region 8, we used a Geographic Information System (GIS) to perform watershed characterizations for the Tongue River, Powder River, and Rosebud Creek TMDL planning areas. Data layers, such as soils, land use, geology, elevation, stream networks, land ownership, and population were input into the GIS to facilitate TMDL development. The GIS was also used to enhance water quality data interpretation. Data were plotted in the GIS to evaluate spatial and temporal trends, and the results were used to select sites for monitoring in 2003. A source analysis was performed with the GIS to identify the impact and extent of sources (e.g., coal mines, CBM wells, irrigated agriculture), and the results were input into the modeling (load identification and allocation) processes of the TMDLs. *Dates: September 2002 to present.*
Kent Patrick-Riley Alaska Department of Environmental Conservation 555 Cordova Avenue Anchorage, AK (907) 269-7554	For Alaska DEC we supported TMDL development in Chester Creek, a large urban watershed by modeling fecal coliform loadings to the creek with the use of the Storm Water Management Model (SWMM). Tt staff provided intensive spatial data compilation and analysis to develop the required input for the SWMM. 15-meter land use and land cover data were reclassified into degrees of imperviousness. Other necessary spatial data included soils, topographic information, and street and storm sewer networks. Street and storm sewer data were used to refine subbasin delineations and impervious fraction estimates, as well as to describe the flow routing characteristics employed in the SWMM. Additionally, we created a series of subbasin maps displaying detailed land use, street networks, and storm sewer networks and outfall locations. These maps were proved valuable to the DEC and the public in their understanding of the physical setting, characteristics, and limitations of the watershed. *Dates: July 2002 to June 2004*
Jim Greenfield U.S. EPA Region 4 Atlanta, GA (404) 562-9238	The Watershed Characterization System (WCS), which is available for the eight states in Environmental Protection Agency (EPA) Region 4 was originally developed to facilitate the physical characterization of watersheds, evaluate water quality conditions, and assess potential sources of impairment using spatial databases and geographic information system (GIS) technology. This was achieved by providing users the capacity to automatically summarize information in tabular and map format in a Microsoft Word document. WCS has now evolved beyond its original objective as a repository of watershed data and a characterization tool. Several modeling extensions have been developed to support advanced TMDL development, including a sediment budget model, mercury loading model, Storm water Management Model (SWMM) GIS interface and input preprocessor, and Nonpoint Source Model (NPSM) GIS interface. The sediment budget model is based on a spatially distributed estimation of erosion (using the Universal Soil Loss Equation, USLE), and sediment load (using any of four alternative sediment delivery equations). It can be used to (1) estimate the extent and distribution of potential soil erosion in the watershed; (2) estimate potential sediment delivery to receiving water bodies; and (3) evaluate the effects of land use, best management practices (BMPs) and road networks on erosion and sediment delivery. The mercury loading model uses the grid-based GIS modeling technology to calculate total soil mercury concentration and mercury loadings from direct atmospheric deposition, surface runoff, soil erosion, and point sources. The SWMM GIS interface uses existing GIS data such as the National Hydrography Dataset (NHD), Multi-Resolution Land use Characteristics (MRLC), and digital elevation model (DEM) to automatically prepare the input for SWMM modeling. Similarly, the NPSM GIS interface uses commonly available GIS data sets to perform HSPF modeling. *Dates: October 1999 to September 2001*

Romell Nandi US EPA Office of Wetlands, Oceans, and Watersheds Washington, DC (202) 566-1203	To assist states in complying with EPA requirements to submit estimates of nonpoint source load reductions associated with their 319 grants, we developed Spreadsheet-based Tool for Estimating Loads and Load Reductions (STEPL) Data Server. STEPL relies on simple algorithms and easy to use interfaces in MS Excel to calculate nutrient and sediment loads from different land use-based activities and sources in the watershed, and ensuing load reductions to the implementation of best management practices. The STEPL Data Server (http://it.tetratech-ffx.com/stepl) allows on-line users to download initial spatial and tabular data for STEPL such as land use distribution, animal counts, and septic system failures for any selected area of interest within the continental US. *Dates: October 2002 to Present*

2.5.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including GIS support. Our staff of over 150 water resource scientists and engineers have developed over 2,000 TMDLs and numerous watershed management plans in all 10 EPA Regions and 40 states. Almost all of these projects has involved some type of GIS support. All work has been performed under the company name Tt, Inc.
This section provides biosketches for the key personnel who will provide primary support in this service category. Many of our other TMDL specialists also have experience in the identification of TMDL targets. Full resumes of all personnel are provided in Appendix A.

Henry Manguerra (Project Manager)
Dr. Manguerra is a water resources/environmental engineer with more than 12 years of professional experience in the areas of watershed management, water quality modeling, nonpoint source pollution assessment, water supply allocation and optimization. His experience includes management and technical oversight of decision support systems, models, database, GIS and web development projects for various water resources and environmental applications. He has practical experience in all parts of the systems life cycle including the assessment of user requirements, system design, implementation, testing, quality assurance and deployment. He has successfully used and integrated diverse and emerging technologies in Internet development, GIS, database management, and computer programming. He has published numerous peer-reviewed technical papers and developed computer models and decision support systems related to his areas of expertise.

Scott Daly
Mr. Daly is an environmental scientist with 2 years experience in watershed management, biomonitoring, and data analysis. He is proficient in aqueous chemistry, hydrologic and geomorphic processes, and taxonomic identification of freshwater macroinvertebrates. In addition, Mr. Daly has knowledge of surface water, ground water, aquatic ecosystems, geology, and statistics. While at Slippery Rock University his course work consisted of Organic Chemistry, Earth Materials, Geomorphology, Ecology, Environmental Microbiology, Biometry, Hydrology, Freshwater Biomonitoring, and Water Quality Assessment. He is also proficient with Corel 9, MS Office, SAS, Arc View, BASINS, Spatial Analyst, 3D Analyst, Network Analyst, and additional GIS tools.

Jason Gildea
Mr. Gildea is an environmental scientist with expertise in water resources, data analysis, and GIS. He has experience using a holistic approach to watershed management that includes applying knowledge of surface water, groundwater, geology, soils, and land use. He has used this approach to support TMDL development for multiple projects throughout the United States. Recent projects include the preparation of TMDLs for the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana. Mr. Gildea has also be extensively involved in the development of sediment TMDLs for the Flathead Headwaters. Mr. Gildea has over five years of experience with data management, GIS software, and electronic datasets. He has performed statistical analyses of water quality data using statistical software, GIS, and remote sensing. While working for the US Geological Survey, he participated in a surface and groundwater sampling program and gained experience in working with USGS water quality data and databases. He is proficient in MS Office, ERDAS Imagine, Arc Info/ Arc View (Unix + PC), Idrisi, and Adobe Photoshop.

Kirk Gregory
Dr. Gregory is an environmental scientist with more than 9 years of experience in hydrologic modeling, geographic information systems (GIS), and remote sensing technologies for urban and agricultural watershed assessment and management. He uses hydrologic models coupled with GIS to assess the impacts of land use change on water quantity and quality. He also uses GIS-based models to examine sediment erosion processes from cultivation and construction activities. He has demonstrated an ability to deliver innovative solutions that encompass local, state, and federal water resource objectives and goals.
Example map showing land use in the Goose Creek subwatershed of the Tongue River Watershed.

Elizabeth Hansen
Mrs. Hansen is an environmental scientist with one year of experience in database compilation, GIS services, and data analysis. Mrs. Hansen has knowledge of surface water, ground water, aquatic ecosystems, geology, and statistics. She has provided GIS support for several watershed projects including Lower Missouri River Watershed, MT, Little Beaver Creek Watershed, Huron River Watershed, East Fork Little Miami River Watershed, OH, and Vermillion River, MN. She is proficient with MS Office, Arc View, BASINS, Spatial Analyst, 3D Analyst, Network Analyst, and additional GIS tools.

Teresa Rafi
Ms. Rafi has more than 7 years of professional experience in public sector environmental science and policy. She has supported numerous aspects of the Coastal Zone Management and Clean Water Acts at both the state and national levels, performing public outreach, interagency coordination, and conflict resolution. She has been a member of the Water Resources Group at Tt, since October 2000, where her activities include TMDL development for fecal coliform and metals-impaired waterbodies, curriculum development for watershed modeling courses, and database development in support of numerous EPA programmatic initiatives. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques, developing strategies for and conducting public outreach initiatives, meeting facilitation, and development of management indicators for gauging program performance.

John Riverson
Mr. Riverson is a water resources engineer with five years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He also has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. He has published engineering and business instructional material for the Darden School of Business Administration (University of Virginia), and has played a supporting role in providing technical analysis, narratives, schematics diagrams, and technical figures for two engineering textbooks and various peer-reviewed technical papers. Mr. Riverson has worked on a variety of projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several state and county water resource operatives, and the US Army Corps of Engineers.

2.5.3 Method of Providing Services and Quality Assurance

Tt is a national leader in TMDL development in large part due to our technical expertise and our ability to provide timely and cost-effective technical services to our clients. We understand that GIS products require customization and we work closely with our clients to satisfy those demands. Our GIS and IT group, located in Fairfax, Virginia, have extensive experience in software development and database project management, requirements definition and management, data modeling, spatial data creation, maintenance, and analysis, and software training. Our work in the development of BASINS is a good example of the methodology we will use to complete projects in this service category.

BASINS system is a multipurpose environmental analysis system for use by environmental agencies in performing watershed and water-quality studies. It was developed by the U.S. Environmental Protection Agency's (EPA's) Office of Water to address three objectives:

- Facilitate examination of environmental information
- Support analysis of environmental systems

- Provide a framework for examining management alternatives

Because many states and local agencies are moving toward a watershed-based approach, the BASINS system is configured to support environmental and ecological studies in a watershed context. The system is designed to be flexible. It can support analysis at a variety of scales using tools that range from simple to sophisticated.

One of BASINS primary uses is in supporting the development of total maximum daily loads (TMDLs). BASINS makes watershed and water quality studies easier by bringing key data and analytical components together. BASINS uses an ArcView GIS interface to access national environmental information, apply assessment and planning tools, and run a variety of proven, robust nonpoint loading and water quality models. With many of the necessary components together in one system, the analysis time is significantly reduced, a greater variety of questions can be answered, and data and management needs can be more efficiently identified. BASINS takes advantage of recent developments in software, data management technologies, and computer capabilities to provide the user with a fully comprehensive watershed management tool. In addition to developing BASINS from its inception, Tt has successfully applied BASINS to TMDL development and watershed modeling throughout the country.

Customization

Recognizing that states have different user-specific requirements, Tt has continually enhanced state-specific versions of BASINS by providing automated data download tools, automated watershed and geological characterization reports, new and improved watershed assessment tools, and new and improved watershed and water quality models. Tt has produced customized versions of BASINS for Alabama, Georgia, Florida, Kentucky, Mississippi, South Carolina, North Carolina, and Tennessee and is completing customizations for New Jersey, Utah, North Dakota, and Puerto Rico and the Virgin Islands.

For these BASINS customizations, Tt has continued to pursue the innovative use and integration of standard and emerging technologies such as Microsoft Office applications (e.g., automated reports in MS Word, spreadsheet-analysis tools using MS Excel, personal geodatabases in MS Access); relational database systems such as Oracle; modern GIS development tools such as ArcIMS, ArcSDE, and ArcObjects; and other conventional non-GIS development programming languages such as C++, VB, VB.Net, and Java. Tt has successfully applied BASINS, and BASINS customizations to develop TMDLs and source water protection plans across the country.

Project Applicability

BASINS is an exemplary demonstration of Tt's innovation and creativity in GIS, water quality, and environmental software development. BASINS also involved the compilation of a comprehensive national spatial environmental data set and preparation of metadata compliant with Federal Geographic Data Committee (FGDC) standards.

2.5.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Dr. Henry Manguerra, is provided above.

Table 2-11. References associated with Service Category 3.5.10 (Geographic Information Systems).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Scott Daly	B.S.	Environmental Science	Yes	2/2	51.05

Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Elizabeth Hansen	B.S.	Water Resources	Yes	1/1	42.99
Henry Manguerra	Ph.D.	Bioresource Engineering	Yes	12/12	154.64
Teresa Rafi	B.A.	Environmental Science	Yes	7/7	87.86
John Riverson	M.S.	Civil/Environmental Engineering	Yes	5/5	104.79

2.6 Service Category 3.5.12: Water Quality Modeling

Tt has a long record of experience in watershed, surface water hydrodynamic, and water quality modeling including: model code development, modification and validation; field data collection, analysis and data base design and implementation; model calibration and verification; integrated watershed-receiving water management; NPDES permitting and TMDL analysis; development and application of post-processing software for model results visualization and animation; and modeling technology transfer to clients. Tt has assembled a project team that has collectively completed hundreds of watershed and receiving water modeling studies to support TMDL development in nearly all 50 states. Because our work has encompassed virtually every water body type (including estuaries, bays, lakes, bayous, reservoirs, major river systems, streams, washes, ponds, and BMPs) and pollutant type (from nutrients, DO, and bacteria to PCBs, metals, and pesticides), we have successfully applied a wide range of models and assessment tools to different situations. Many of these models and tools have been developed in-house to support our clients' needs.

2.6.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references.

Table 2-12. References associated with Service Category 3.5.12 (Water Quality Modeling).

Reference Information	Description of Service
Thomas Henry USEPA Region 3 Philadelphia, PA (215) 814-5752	Over the past 10 years, Tt has been critical in enabling EPA Region 3 to meet stringent court-imposed TMDL deadlines by developing a multitude of TMDLs for a range of pollutants, sources, and waterbody types using various water quality models. Tt has worked closely with EPA and the states to establish TMDLs in West Virginia, Pennsylvania, Delaware, Virginia, and the District of Columbia. Tt developed pilot methods in the region for bacteria TMDLs, and in doing so, completed 12 fecal coliform bacteria TMDLs in Virginia and West Virginia (the first such of their kind in both states) using HSPF/NPSM. Tt has also supported the region in developing biological TMDLs where water quality standards do not include numerical criteria for assessing benthic community data. The approach determines appropriate TMDL targets through benthic community stressor identification analyses and involves modeling both the impaired watershed and a reference watershed using GWLF to identify appropriate pollutant targets. Tt developed the first biological TMDLs in Virginia using the method for Blacks Run and Cooks Creek, and has submitted TMDLs to EPA for a number of additional watersheds. Tt has supported TMDL-related efforts in Delaware including EFDC modeling support and TMDL development for nutrient and dissolved oxygen impairments in the Christina River Basin, as well as applying EPA's WASP eutrophication model as a framework to conduct the TMDL analysis for the Appoquinimink and Nanticoke Rivers. Tt developed a TSS TMDL for the Anacostia River in D.C. through application of an existing WASP water quality model. Tt also developed siltation TMDLs for Mountwood Park Lake, Burches Run Lake, and Tomlinson Run Lake using HSPF/NSPM and EFDC in West Virginia and developed PCB TMDLs for the Flat Fork, WV and the Shenandoah River, VA using an in-house spreadsheet model. Tt recently completed nutrient, DO, and siltation TMDLs for Lake Nockamixon and Green Lane Reservoir in

	Pennsylvania using a combination of GWLF and BATHTUB. Additional work in Pennsylvania has involved development of 9 nutrient and 17 sediment TMDLs using a reference watershed approach and GWLF for the Conodoguinet watershed, as well as low-flow and high-flow TMDLs to address sediment and DO impairments using GWLF and WASP, respectively for the Wissahickon watershed. *Dates: May 1994 to Present*
Dave Montali West Virginia DEP Charleston, WV (304) 558-2837	Over the past 5 years, Tt has worked with West Virginia DEP and USEPA Region 3 to develop and fine-tune a TMDL methodology to address mining-related impairments. A key component of the methodology is the Mining Data Analysis System (MDAS), which is a comprehensive GIS, dynamic modeling, and analysis package that Tt created to support TMDL development work in West Virginia. To date, Tt has developed over 1,300 mining-related TMDLs in West Virginia alone using the methodology to meet strict consent decree deadlines, including more than 300 waterbodies and 6 different pollutants (pH, Aluminum, Iron, Manganese, PCBs, siltation). Completed TMDLs cover nearly 50% of total watershed area in the state and were developed through nearly 20 separate projects, the largest of which included entire river basins: Tygart, Monongahela, West Fork, and Tug. *Dates: October 1999 to Present*
David Smith USEPA Region 9 San Francisco, CA (415) 972-3416	Tt supported USEPA Region 9 in the development of a temperature TMDL for the Middle Fork Eel River, CA. The support was targeted to the calculation of solar temperature loading to the stream through the development of a custom GIS-modeling system that could be used for the development of future temperature TMDLs in the North Coast Region. The integrated modeling system is comprised of a GIS-Based SHADE model with pre-and post processors and a customized Qual2E model (Q2ESHADE) with inbuilt pre-and post processors for TMDL development. The SHADE model calculates the amount of solar radiation reaching a stream element taking into account topography of the watershed and riparian vegetation characteristics adjacent to the stream. The modified QUAL2E model was linked to the SHADE output and used the localized solar radiation to perform the heat flux and transport calculations in the stream. This modeling system was used to predict shading effects and temperatures for multiple locations within the Middle Fork Eel River watershed and assess relationships with riparian vegetation characteristics and topography. Various scenarios based on varying the Diameter-at-Breast and tree height conditions were simulated for TMDL development. This innovative new technology was customized to generate output files, loading tables and maps. *Dates: May 2002 to June 2003*
Laura Sheely Mississippi DEQ Jackson, MS (601) 961-5657	Tt supported Mississippi DEQ in developing organic enrichment/nutrient, low DO, and sediment TMDLs for 5 oxbow lakes and two of their tributaries in the Yazoo River Basin, Mississippi. The effort involved application of the GWLF watershed model to predict nonpoint source sediment and nutrient loads to the lakes, application of the CE-QUAL-W2 model for dynamic, 2-dimensional representation of hydrodynamics and water quality effects in the lakes, and application of the QUAL2E model for simulation of DO in the tributaries. A sediment loading rate target was identified for the watershed, in order to address Mississippi's narrative criteria and to extend the lakes' lifespans. Minimum daily DO concentration targets were achieved for the lakes through model scenario simulations involving reduction of incoming nutrients. *Dates: October 2002 to May 2003*

Rick Whetsel Santa Ana Watershed Project Authority Riverside, CA (909) 354-4222	Tt supported the Santa Ana Watershed Protection Authority (SAWPA) and the Santa Ana Regional Water Quality Control Board (RWQCB) in developing nutrient and bacteria TMDLs for Lake Elsinore and Canyon Lake, located within the San Jacinto watershed, California. The effort involved development and application of a linked watershed-lake modeling system. The LSPC model was applied to simulate watershed processes, including hydrology and pollutant accumulation and washoff. LSPC was fully calibrated and validated for hydrology and pollutant loading at multiple locations in the watershed and predicted flow and pollutant loads to Canyon Lake over an extended time period. In order to simulate pollutant loading impacts on Canyon Lake (from the watershed) and transport to the downstream lake, Lake Elsinore, a simplified two-dimensional EFDC model was developed. EFDC is capable of simulating hydrodynamics, salinity, temperature, suspended sediment, water quality, and the fate of toxic materials. It was successfully calibrated to available hydrodynamic and water quality data for a multi-year period covering mean, dry, and wet years. Various alternative loading scenarios were simulated with the LSPC and EFDC models, in order to test the sensitivity of various pollutant source loadings to lake water quality response. These scenarios were used to arrive at source-based load allocations for development of the TMDLs. The comprehensive modeling system, composed of both the LSPC and EFDC models, provides the basis for making future management decisions in the watershed. *Dates: January 2002 to January 2003*
Jim Greenfield USEPA Region 4 Atlanta, GA (404) 562-9238	For USEPA Region 4 and Georgia DEP, Tt developed an innovative modeling approach and methodology for addressing the dynamic factors that influence naturally low dissolved oxygen conditions in blackwater streams. Despite a limiting time constraint, Tt successfully developed and applied this innovative approach to 99 listed streams distributed throughout 16,000 square miles of forested, wetland, urban, and agricultural land in southern Georgia. Impaired waterbodies were modeled using both a dynamic watershed model and a dynamic receiving waterbody model. The watershed model was developed using BASINS and the NPSM/HSPF, while an EFDC water quality and sediment diagenesis model was applied to simulate processes in the listed reaches. The linkage of these models permitted representation of major processes associated with dissolved oxygen concentration variability. The modeling approach also allowed for separation of anthropogenic loads from natural loads and background conditions. Dates: April 2000 to October 2000

2.6.2 Company Profile and Experience

Tt's philosophy of model development is to emphasize strong technical and scientific credibility and practical function in conjunction with the integration of state-of-the-art GIS and software systems to facilitate application. We have developed efficient procedures to integrate watershed and receiving water models, evaluate management needs, assess PS/NPS pollution control alternatives at multiple scales, and estimate pollutant loads from all types of watershed resource areas (urban, agriculture, forest and silviculture, marinas, industrial discharges and air emissions, and contaminated sites). Tt modelers have designed and tested quantitative hydrologic, watershed, and in-stream water quality modeling systems and have developed evaluation systems to select and optimize the performance of best management practices (BMPs). Modeling systems and applications developed in-house include:

- **EFDC (Environmental Fluid Dynamics Code).** EFDC is a one-, two-, or three-dimensional hydrodynamic and water quality model that can be used to simulate conventional and non-conventional pollutants in streams, rivers, lakes, reservoirs, bays, and estuaries. It is a widely accepted model that has been applied to hundreds of waterbodies world-wide to address simple to complex environmental issues.
- **LSPC (Loading Simulation Program C++) and MDAS (Mining Data Analysis System).** LSPC and MDAS are modeling systems originally created to support watershed-scale modeling. Both systems use ESRI's MapObjects and MS Access to handle spatial and nonspatial data storage, access, and processing requirements. MDAS focuses on mining issues, including metals and pH, while LSPC can be applied to conventional pollutants, such as nutrients and bacteria. Modeling algorithms in both systems are based on those in EPA's HSPF model.

- **Modeling Toolbox.** The Modeling Toolbox is a network of pre-existing environmental models that provides seamless communication between models, as well as state-of-the-art postprocessing capabilities. The models include comprehensive watershed models, such as SWMM and LSPC, as well as dynamic receiving water models to address any waterbody type, such as EFDC, RIV-1, and WASP.
- **The BMP Evaluation Computer Application for Planning and Management Controls Implementation.** Tt developed this model in conjunction with Prince George's County. It is a predictive tool for evaluating the effectiveness of BMP configurations for stormwater and runoff management from multiple sources under various storm conditions, including critical conditions associated with TMDL development. The model is an ideal platform for evaluating the design and placement of non-point source controls necessary for meeting water quality objectives. It provides the continuous simulation of hydrographs and pollutant loads and concentrations so that the effectiveness of LID approaches can be simulated within large-scale watersheds models such as HSPF and SWMM.

The table below lists the environmental computer models typically used by Tt.

Table 2-13. Environmental Computer Models Typically Used by Tetra Tech

Model Category	Model Name
Ecological	IFIM, HEP
Watershed Runoff	HSPF, NPSM, LSPC, MDAS, SWMM, HEC-1, TR-20, PSURM, WSTT, GWLF, AGNPS, P8
Thermal Fate	EFDC, TRANQUAL, HSPF, DISPER, ELA
River Hydraulics	HEC-2, HEC-RAS, WSPRO, FESWMS-2DH, DAMBREAK, DWOPER, UNET
Hydrodynamics	EFDC, CAFE, TEA, CE-QUAL-W2, TABS-2, FESWMS-2DH, DYNHYD5, MIT-DNM, CH3D
Discharge Plume	CORMIX, EPA Plume Models
Mixing Zone	CORMIX, EFDC, TEA/ELA, CAFE/DISPER
Eutrophication	QUAL2E, QUAL2K, WASP, CE-QUAL-W2, CE-QUAL-RIV1, RIVHW, EFDC, BATHTUB
Toxic Fate	TOX15, SMPTOX, RIVRISK, AMMTOX, TOXCALC
Sediment Transport & Scour	TABS-2, STUDH, HEC-6, QUASED, HEC-RAS, CONCEPTS
Ground Water	MODFLOW, MOC, PLASM, Random Walk, GLEAMS

This section provides biosketches for the key personnel who will provide primary support in this service category. Most of these personnel also have significant experience in other service categories. Full resumes of all personnel are provided in Appendix A.

Andrew Parker (Project Manager)
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Clary Barreto-Acobe
Ms. Barreto is a water resources and environmental engineer with three years of professional experience and two years of research experience in the areas of hydrology, hydrodynamics, water quality, sediment transport, coastal processes and groundwater. She has developed and applied computer models to simulate the fate and transport of pollutants in streams, lakes, estuaries and coastal regions. Ms. Barreto has been a technical lead on a number of large-scale modeling efforts and at times directs the work of several junior staff. She has excellent data management and modeling skills and has developed new data analysis and water quality calibration techniques. Ms. Barreto assisted with the development of the Loading Simulation Program in C++ (LSPC) and BASINS. She has worked independently and as part of teams to accomplish time-sensitive tasks. Her experience also includes writing water quality sampling plans and TMDL documents. Ms. Barreto is proficient in the use of ArcView GIS, Microsoft Access, Mining Data Analysis System (MDAS), LSPC, BASINS, HSPF, GWLF, QUAL2K, HEC-HMS, HECRAS and MODFLOW. She has significant experience programming in C++, FORTRAN, and MATLAB. Ms. Barreto is also fluent in English and Spanish.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

Mustafa Faizullabhoy
Mr. Faizullabhoy is a water resources/environmental engineer with more than 2 years of professional experience in the areas of water quality modeling, storm water management planning and design, hydrologic and hydraulic modeling, open/closed storm drain design and analysis, storm water sampling, and TMDL development. He has developed TMDLs for EPA Regions 3, 4, and 9 for a variety of pollutants and waterbody types. For the development of a copper TMDL for Haiwee Reservoir, CA, he supported the development of a model to simulate the sediment water column interaction for copper in the reservoir. Currently, Mr. Faizullabhoy is supporting several EPA engineering and cost studies for BMPs associated with several agricultural industries. He is also providing support for the development of TMDLs for Newport Bay and the application of CE-QUAL-W2 for a modeling study for the Tongue River Reservoir in Montana.

Ana García
Dr. García has extensive experience in the mathematical modeling of fundamental physical phenomena, with an emphasis on watershed modeling. Her graduate work, both at the Master's and Ph.D levels, involved the development of new simulation models. She developed a simulation model to solve various environmental problem, including subsurface and channel flow in tile drained watersheds. She has published several academic articles in water resources as well as in mechanical engineering journals. At Tt, Dr. García has been the lead modeler for an extensive modeling study of the Tongue River, Powder River, and Rosebud Creek watersheds in southeastern Montana and northeastern Wyoming. She has also applied her expertise in agro-hydrology in the development of several TMDLs for US EPA Regions 4 and 5, Ohio EPA, Illinois EPA and Indiana Department of Environmental Management (IDEM). She also works on quality assurance issues as they pertain to the use of water quality and hydrologic models in TMDL development.

Yoichi Matsuzuru
Mr. Matsuzuru is an environmental scientist with 6 years of professional experience in Water Resource field. The experiences include developing the Total Maximum Daily Load (TMDL) Program under Clean Water Act section 303(d) in South Carolina, West Virginia, Arizona, and Florida state government. He also has a field

research experience in assessing biogeochemical cycles in subsurface and surface water at the Southeastern Tree Research and Education Site Project in North Carolina. He has a programming skill in FORTRAN and other computer languages. He is currently the task leader for the technical support and development of South Carolina's pathogens TMDLs.

Teresa Rafi
Ms. Rafi has more than 7 years of professional experience in public sector environmental science and policy. She has supported numerous aspects of the Coastal Zone Management and Clean Water Acts at both the state and national levels, performing public outreach, interagency coordination, and conflict resolution. She has been a member of the Water Resources Group at Tt, since October 2000, where her activities include TMDL development for fecal coliform and metals-impaired waterbodies, curriculum development for watershed modeling courses, and database development in support of numerous EPA programmatic initiatives. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques, developing strategies for and conducting public outreach initiatives, meeting facilitation, and development of management indicators for gauging program performance.

John Riverson
Mr. Riverson is a water resources engineer with five years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He also has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. He has published engineering and business instructional material for the Darden School of Business Administration (University of Virginia), and has played a supporting role in providing technical analysis, narratives, schematics diagrams, and technical figures for two engineering textbooks and various peer-reviewed technical papers. Mr. Riverson has worked on a variety of projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several state and county water resource operatives, and the US Army Corps of Engineers.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt's Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

Nancy Sullins
Ms. Sullins has 20 years of project management experience with over 9 years of experience concentrated in regulatory water quality issues. This experience includes receiving water modeling (QUAL2E, WASP, WQMap, BRANCH/BLTM, EFDC, CE-QUAL-W2, CORMIX, STELLA and CWQM), water shed modeling (LSPC, GWLF), water quality analysis, selection of water quality targets, standards interpretation, water quality

evaluations for Environmental Impact Assessments and Environmental Impact Statements as well as NPDES permit limit development. She has also been involved in various point and nonpoint source policy issues such as nutrient load trading and atmospheric deposition. She is experienced in the application of dynamic multi-dimensional water quality models used to determine TMDLs and NPDES permit limits in fresh water and estuarine systems. She has been actively involved in several projects focusing on water quality standards and methodology development.

2.6.3 Method of Providing Services and Quality Assurance

Tt follows the same general procedure for each TMDL modeling project that we conduct. The following steps summarize the process:

- Existing data collection, water quality analysis, and watershed characterization;
- Model selection;
- Recommendations for targeted in-stream monitoring data collection;
- Model development, calibration, and validation;
- Model application for TMDL analysis and report development; and
- Presentation of approach and results to the public.

It should be noted that every project we conduct abides by the rules of our Company Quality Management Plan. Additionally, we have developed an EPA-approved Quality Assurance Project Plan that applies to all TMDL modeling work we conduct.

An excellent example of the methodology we will use (i.e., the process identified in the list above) to complete projects for this service category is application of the MDAS (Mining Data Analysis System) model to development of metals and pH TMDLs for the Tug Fork Watershed, in West Virginia (which was identified in the table above for support to West Virginia DEP). The Tug Fork River drains approximately 1,500 square miles, 60 percent of which lies in West Virginia, 30 percent in Kentucky, and the remaining 10 percent lies in Virginia. The heavily forested watershed lies in the coalfields of southern Appalachia, where large mining and forestry operations exist. The Tug Fork River and 63 of its tributaries were included on West Virginia's 1996 and 1998 Section 303(d) lists for metals and/or pH impairments. Specifically, the Tug Fork River mainstem does not support its aquatic life and human health designated uses due to total aluminum, total iron, and zinc impairments. Additionally, the Tug Fork mainstem was included on Kentucky's 1998 Section 303(d) list as impaired by pathogens, siltation, and organic enrichment/low dissolved oxygen.

Existing data collection, water quality analysis, and watershed characterization

The first step in the TMDL development process for the Tug Fork Watershed was an overall assessment of the watershed and receiving water characteristics through a historical data review. Tt compiled, reviewed, and summarized all relevant data and information available for the Tug Fork, its tributaries, and its contributing watershed. This assessment laid the groundwork for subsequent monitoring, modeling, and TMDL development. The following discussion highlights some of the assessment components that were addressed.

Assessment of the Tug Fork Watershed included identification of the impairment extent, designated uses, applicable water quality criteria/TMDL targets, and physical, flow, and water quality monitoring data. Tt compiled a wealth of water quality data from numerous sources – both at the national (USGS) and regional levels (WV DEP, KY DEP, VA DEQ). Tt even worked with WV DEP to obtain in-stream monitoring data from mining companies that is required by the NPDES program. Historical water quality monitoring data were evaluated for quality assurance and compared to water quality criteria to confirm impairments and to identify the potential for delisting. Correlative and statistical analyses were performed to identify relationships among water quality parameters and flow conditions. Additionally, all monitoring data were evaluated for adequacy to support various levels of modeling and TMDL development. The spatial, temporal, and parameter-specific adequacy of the water quality data were reviewed to ensure a sound understanding of conditions critical to impairments, background conditions, storm-flow conditions, and source contribution levels.

Watershed assessment refers to the review and analysis of all data related to the physical aspects of the landscape and point and nonpoint sources contributing to the Tug Fork impairments. Watershed data critical to modeling for TMDLs include landuse, geology, soils, meteorology/climate, land practices, waste treatment, and point source discharges. All point and nonpoint sources were fully assessed during the data review process. Critical nonpoint sources impacting the metals and pH impairments in the watershed included abandoned mines and sediment sources (both naturally-occurring and human-induced). Key mining point sources impacting the impairments were also analyzed.

Data to support the assessment were obtained from a range of state, federal, and local agencies, and are listed in Table 2-14. The assessment process included identification of available data, summary of watershed conditions, initial estimation of watershed source contributions, and identification of additional necessary data. Tt submitted a data review report to West Virginia DEP and EPA Region 3.

Table 2-14. Inventory of data and information used to develop the Tug Fork Watershed TMDLs

Data Category	Description	Data Source(s)
Watershed Physiographic Data	Land Use (MRLC)	U.S. Geological Survey (USGS)
	Abandoned Mining Coverage	WVDEP Division of Mining & Reclamation (DMR)
	Active and historical mining information	WVDEP DMR, KY Department for Surface Mining Reclamation and Enforcement (DSMRE)
	Soil data (STATSGO)	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)
	Stream Reach Coverage	USGS, WVDEP Division of Water Resources (DWR)
	Weather Information	National Climatic Data Center
	Oil and Gas Operations Coverage	WVDEP Office of Oil and Gas (OOG), KY Division of Oil and Gas, (DOG), University of Kentucky (UK)
	Paved and Unpaved Roads	WV Department of Transportation (DOT), KYDOT, VDOT, USDOT
	Timber Harvest Data	USDA, U.S. Forest Service (USFS)
Environmental Monitoring Data	NPDES Data	WVDEP DMR, WVDEP DWR, KY DEP Division of Water (DOW)
	Discharge Monitoring Report Data	WVDEP DMR, KY DSMRE
	Abandoned Mine Land Data	WVDEP DMR, WVDEP DWR
	303(d) Listed Waters	WVDEP DWR, VA DEQ, KYDEP DOW
	Water Quality Monitoring Data for 685 Sampling Stations	EPA STORET, WVDEP DWR, WVDEP DMR, KYDEP DOW, Mining Industry

Model Selection

Model selection occurred after collecting and reviewing data and characterizing the watershed system. Tt has developed a formalized model selection process that considers a range of technical, regulatory, and user criteria. Key technical considerations include chemical targets; key physical, chemical and biological processes in the system; data availability (which was ultimately maximized through focused monitoring for the project); and identification of the potential management/implementation strategies. This process was utilized in model selection for the Tug Fork TMDL and provided a structured and quantifiable determination of the appropriate model.

The model selected to support TMDL development was MDAS, a stand-alone modeling and assessment system that addresses water quality impairments due to point and nonpoint source mining contributions. MDAS combines (1) a stand-alone GIS interface (does not require ArcView), (2) HSPF algorithms ported to the C++ language that can conveniently be updated, expanded, and linked directly to other models and can be applied to any watershed regardless of size, number of subwatersheds, and number of pollutants,

(3) a database that stores all landscape, stream, meteorological, flow, and water quality monitoring data, model input parameters, and model output and can be accessed using Microsoft Access or similar database packages, and (4) a postprocessing system with advanced capabilities that communicates directly with the system's database.

Recommendations for targeted in-stream monitoring data collection

The historical data assessment identified that additional sampling in the Tug Fork River system was necessary to meet the temporal and spatial resolution requirements for modeling. Specific locations for monitoring were defined, in large part based on the locations where existing sample data were collected. Key information for identifying sampling locations included location coordinates, maps, and location descriptions.

Data gathering was a cooperative effort among WV DEP, KY DEQ, and VA DEQ. In addition, residents of West Virginia and Kentucky participated in a volunteer water quality monitoring program with WV DEP and KY DEP by collecting and transporting samples during watershed-wide monitoring sweeps.

Model development, calibration, and validation

After selecting the appropriate modeling framework, MDAS, the following steps were completed to develop and test the model for TMDL development:

- Watershed Segmentation
- Configuration of Key Model Components
- Model Calibration and Validation

Watershed Segmentation
Watershed segmentation refers to the subdivision of the watershed into smaller, discrete subwatersheds for modeling and analysis. For the Tug Fork Watershed, this subdivision was scaled to the extent and size of the impaired stream segments. For example, watersheds containing impaired smaller headwater streams required a higher resolution watershed segmentation. Segmentation was based on the impaired segment locations, stream network, topographic variability, locations of flow and water quality monitoring stations, consistency of hydrologic factors, and landuse consistency.

Configuration of Key Model Components
Configuration of the model itself involved consideration of four major components:

- Meteorological data
- Land use representation
- Hydrologic representation
- Pollutant representation
- Waterbody representation

These components provided the basis for the model's ability to estimate flow and pollutant loadings. Meteorological data essentially drive the watershed model. Rainfall and other parameters are key inputs to MDAS's hydrologic algorithms. The land use representation provided the basis for distributing soils and pollutant loading characteristics throughout the basin. Hydrologic and pollutant representation refer to the MDAS modules or algorithms used to simulate hydrologic processes (e.g., surface runoff, evapotranspiration, and infiltration), and pollutant loading processes (primarily accumulation and washoff). Waterbody representation refers to MDAS modules or algorithms used to simulate flow and pollutant transport through streams and rivers.

Meteorological data were a critical component of the watershed model. Appropriate representation of precipitation, wind speed, potential evapotranspiration, cloud cover, temperature, and dew point were required to develop a valid model. These data provided necessary input to MDAS algorithms for hydrologic and water quality representation. Meteorological data were accessed from a number of stations within and in close proximity to the watershed. Rainfall-runoff processes for each of the subwatersheds in the model were driven by hourly rainfall data from the most representative station(s).

The watershed model required a basis for distributing hydrologic and pollutant loading parameters. This was necessary to appropriately represent hydrologic variability throughout the basin, which is influenced by land surface and subsurface characteristics. It was also necessary to represent variability in pollutant loading, which is highly correlated to land practices. The basis for this distribution was provided by a combination of the USGS MRLC land use coverage and data for precipitation-driven mining sources.

MDAS algorithms require that land use categories be divided into separate pervious and impervious land units for modeling. This division was made for the appropriate land uses, in order to represent impervious and pervious areas separately. The division was based on typical impervious percentages associated with different land use types from the Soil Conservation Service's TR-55 Manual. MDAS model algorithms simulating major hydrologic and pollutant loading processes were applied to each pervious and impervious land unit, and these include PWATER and IWATER, respectively (identical to HSPF). Designation of key hydrologic parameters were based on Tt's extensive modeling experience, existing default parameter databases that were developed by Tt for the region, and on an assessment of STATSGO and SSURGO soils data. Starting values were refined through the hydrologic calibration process.

Metals were represented in the watershed model for each land unit using the HSPC PQUAL and IQUAL modules (identical to those in HSPF). These modules simulated the accumulation of pollutants during dry periods and the washoff of pollutants during storm events. Starting values for parameters relating to land-use-specific accumulation rates and buildup limits were applied based on literature and Tt's past modeling experience in the region. The starting values were refined through the water quality calibration process.

Modeling an entire watershed required routing flow and pollutants through numerous stream networks. These stream networks connected all of the subwatersheds represented in the watershed model. Routing required development of rating curves for major streams in the networks, in order for the model to simulate hydraulic processes. Stream characteristics from available monitoring data and existing databases were used to develop rating curves for one representative stream in each subwatershed. Streams were be assumed to be completely-mixed, one-dimensional segments with a trapezoidal cross-section for this application. In-stream flow calculations were made using the HYDR module in MDAS (identical to that in HSPF), while in-stream pollutant transport was performed using ADCALC and GQUAL.

Model Calibration and Validation

After initially configuring the watershed model, model testing was performed. Model testing involved calibration and validation. Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. The calibration was performed for different MDAS modules at multiple locations throughout the watershed. This approach ensured that heterogeneities were accurately represented. The model validation was performed to test the calibrated parameters at different locations and for different time periods, without further adjustment. Upon completion of the calibration and validation at selected locations, a calibrated dataset containing parameter values for each modeled land use and pollutant was developed.
Calibration and validation were completed by comparing time-series model results to monitoring data. Output from the watershed model was in the form of hourly/daily average flow and hourly/daily average concentrations for the modeled metals for each of the subwatersheds. Flow monitoring data were available at USGS flow gauging stations located throughout the watershed.

Hydrology was the first model component calibrated, and it involved a comparison of observed data from in-stream USGS flow gauging stations to modeled in-stream flow for 5 locations, and an adjustment of key hydrologic parameters. The calibration year, 1990, was selected based upon an examination of annual precipitation variability and the availability of observation data. The period was determined to represent a range of hydrologic conditions: low, mean, and high flow conditions. Calibration for these conditions was necessary to ensure that the model will accurately predict a range of conditions for a longer period of time.

Key considerations in the hydrology calibration included the overall water balance, the high-flow-low-flow distribution, storm flows, and seasonal variation. Two criteria for goodness of fit were used for calibration: graphical comparison and the relative error method. Graphical comparisons were extremely useful for judging the results of model calibration; time-variable plots of observed versus modeled flow provided insight into the model's representation of storm hydrographs, baseflow recession, time distributions, and other pertinent factors often overlooked by statistical comparisons. The model's accuracy was primarily assessed through interpretation of the time-variable plots. The relative error method was used to support the goodness of fit evaluation through a quantitative comparison.

After calibrating hydrology at multiple locations, independent sets of hydrologic parameters were developed and applied to the remaining subwatersheds in the basin. A validation of these hydrologic parameters was made through a comparison of model output to observed data at additional locations in the watershed. The validation locations represented larger watershed areas and essentially validated application of the hydrologic parameters derived from the calibration of smaller subwatersheds. Validation was assessed in a similar manner to calibration.

After hydrology was sufficiently calibrated, water quality calibration was performed. Modeled versus observed in-stream concentrations were directly compared during model calibration. The water quality calibration consisted of executing the watershed model, comparing water quality time series output to available water quality observation data, and adjusting pollutant loading and in-stream water quality parameters within a reasonable range. The objective was to best simulate low flow, mean flow, and storm peaks at water quality monitoring stations representative of different regions of the basin (and different landuses, in particular). Water quality data from monitoring stations was used to calibrate landusespecific pollutant loading parameters. Knowing the locations of abandoned mine discharges and other point source discharge outlets with respect to the monitoring stations was critical in successfully calibrating the water quality portion of the model. Water quality calibration adequacy was primarily assessed through careful review of time-series plots, and secondarily through statistical measures (e.g., correlation). Water quality parameters for the watershed model were validated through a comparison of observed water quality data to modeled in-stream values, as with the calibration.

Model application for TMDL analysis and report development

TMDLs, by definition, are combinations of wasteload allocations (WLAs) and load allocations (LAs) that distribute a waterbody's assimilative capacity to various loading sources to achieve water quality goals. TMDLs also include a margin of safety and consider seasonal variation. An important step in the selection of final load and wasteload allocations was analyzing the magnitude and significance of each source on the in-stream waterbody response. This analysis identified the relative significance and influence of each source of metals and to what degree loading reductions of individual source categories would result in changing in-stream conditions. The sensitivity analysis guided the determination of what allocation scenarios were technically feasible and whether combinations of load reductions could potentially result in meeting water quality standards.

A number of different state specific regulatory issues arose during TMDL development for the Tug Fork watershed. For example, West Virginia and Kentucky specify similar designated uses for the Tug Fork mainstem. However, the applicable water quality criteria for the each designated use differ significantly, which ultimately led to inconsistent Section 303(d) listings. Since the Tug Fork TMDL was developed to address the impaired waterbodies in West Virginia, West Virginia’s numeric water quality criteria for aluminum and iron and an explicit margin of safety (MOS) were used to identify endpoints for TMDL development.
After assessing the impact critical sources had on the in-stream water quality, development of feasible source loading reduction strategies followed. Tt worked closely with state agencies and stakeholders to identify the optimal mechanisms for achieving water quality criteria under the appropriate critical conditions. TMDLs and source allocations were developed for impaired segments of West Virginia tributaries and the Tug Fork mainstem.

Tt prepared a technical report for the Tug Fork Watershed TMDL project. This report included the problem understanding, relevant water quality criteria/TMDL targets, source assessment and characterization, waterbody assessment, modeling approach, and results, monitoring results, and all required TMDL components (WLAs, LAs, MOS, and seasonality). The report was submitted in draft form and then modified based on agency and stakeholder (as directed by the agencies) comments.

Presentation of approach and results to the public

In addition to federal and state agency cooperation, stakeholder involvement also played an important role in the TMDL development for the Tug Fork watershed. Tt provided technical support for public meetings over the course of the project and presented the modeling and TMDL approach and results at the final public meeting.

2.6.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Mr. Andrew Parker, is provided above.

Table 2-15. References associated with Service Category 3.5.12 (Water Quality Modeling).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience1	Loaded Hourly Rate
Clary Barreto-Acobe	M.S.	Environmental Engineering	Yes	4/4	47.20
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
Mustafa Faizullabhoy	M.S.	Civil/Environmental Engineering	Yes	4/4	81.58
Ana Garcia	Ph.D.	Agricultural Engineering	Yes	5/5	88.67
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Yoichi Matsuzuru	M.S.	Water Resources	Yes	4/4	87.72
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74
Teresa Rafi	B.A.	Environmental Science	Yes	7/7	87.86
John Riverson	M.S.	Civil/Environmental Engineering	Yes	5/5	104.79
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
Nancy Sullins	M.P.H.	Environmental Quality	Yes	20/20	102.50

Service Category 3.5.13: Statistical Analysis

Tt has extensive experience in statistically analyzing large data sets for determining trends or for making comparisons. We have numerous individuals thoroughly familiar with water quality databases such as STORET, NWIS, and PCS, as well as Montana's STOREASE. We understand that this service area be used to establish a relationship or linkage between indicators and targets, the estimated loads and how targets link to beneficial use support and we have extensive experience in this area through our cutting-edge Stressor Identification work being completed for EPA.

2.6.5 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references.

Table 2-16. References associated with Service Category 3.5.13 (Statistical Analysis).

Reference Information	Description of Service
Paul Braasch Office of Environmental Quality Batavia, OH (513) 732-7745	Tt assembled an extensive database of water quality, biological monitoring and land use data from the entire East Fork of the Little Miami River (EFLMR) and its tributaries. Tt is currently compiling and integrating the information for use in TMDL development, and will develop a strength-of-evidence analysis of potential stressors in the subwatersheds responsible for nonattainment, using EPA's Stressor Identification methodology. This effort will coordinate the work of various Tt projects completed already in Clermont County - primarily the synthesis of water quality, geomorphic characterization, and watershed contaminant transport modeling. In addition, Tt will develop a new model for ascertaining impacts in small streams of the Pre-Wisconsinan Drift Plains. Tt will conduct statistical analyses relating habitat, land use, and chemical factors to biological metrics and indices at specific sites in the watershed to guide decision-making for management of the EFLMR. Determining the statistical relationship between biological response and physical and chemical stressors will enable the Project Team to more accurately develop nutrient and sediment TMDLs that, once implemented, will result in much greater improvements in the biological community and achievement of aquatic life use support. *Dates: November 2003 to Present*
Roy Smogor Illinois EPA Springfield, IL (217) 785-3961	Tt reviewed and evaluated Illinois EPA's (IEPA) biological monitoring program to (1) evaluate a 25-year ecological data base for its validity to establish a framework for a statewide biological index; (2) evaluate methods for refinement and modification to enhance Illinois' biological program; (3) recommend a site classification strategy to improve assessment of biological condition in different regions of the state; and (4) conduct multivariate and univariate analyses on the ecological data to provide an index for assessing quality and attainment to designated aquatic life use. Using IEPA's long-term database, Tt applied statistical QA and data analysis procedures to develop a stream condition index (univariate procedures), and also developed a multivariate predictive model to assess stream condition with a variety of statistical software packages (e.g., PC-ORD, Statistica, SYSTAT). This was the first comparative development of both a metric index and a multivariate predictive model for the same data set. Based on the results of the analysis, Tt recommended changes to IEPA's sampling program to obtain more representative samples and to apply a probabilistic sampling design component to statewide assessments. Based on Tt's recommendations, IEPA has implemented the sampling design and is testing the site-specific sampling methods. In the final phase of the project, Tt will evaluate the new results to develop more definitive biological indicators, including uncertainty estimation and power analysis for the sampling program. *Dates: July 1999 to June 2003*

Gerold Szal Massachusetts Department of Environmental Protection Boston, MA (617) 338-2255	The Massachusetts Department of Environmental Protection (MADEP) is working towards development of the thresholds for impairment, methods, and controls that would allow evaluation of biological degradation surrounding permitted discharges. Tt provided analytical support for recommendations of the sampling and assessment protocols that would be implemented throughout the state. A study of macroinvertebrate communities upstream and downstream of known stressors was conducted using data from New York, Maine, and Vermont because appropriate data were unavailable from Massachusetts's streams. The analysis determined the sensitivity, consistency, and precision of metric responses. These metric response characteristics were evaluated in light of sampling procedures and applicability in Massachusetts's regulation of discharges. Kicknet sampling methods were found to yield better metric responses than artificial substrates. The recommended assessment protocols proceeded in steps, first applying the relative Euclidean Distance metric to screen for overall community changes from locations upstream of the stressor to locations downstream. If the community differences were found to be significant, then additional metrics would be calculated, evaluated separately, and evaluated again after combination into multimetric indices. Because precision had been estimated, it was possible to calculate upstream – downstream metric differences that were greater than the sampling error and were therefore indicative of significant degradation. Ongoing analysis of upstream – downstream community differences in streams without intervening stressors will provide estimates of metric differences that can be attributed to natural variability. This additional information will allow for setting thresholds for metric differences that are attributable to discharge impacts. *Dates: October 1999 to May 2002*
Kathryn Hernandez TMDL Specialist USEPA Region 8 Denver, CO (303) 312-6101	EPA is requiring states and regions to develop numeric nutrient criteria to manage excessive levels of nutrients identified in surface waters of the United States. In order to develop nutrient criteria, EPA regions and states have recognized the need to identify reliable reference conditions with respect to nutrient concentrations, and to determine early stages of biological impairment from nutrient enrichment. EPA Region 8 assigned Tt to design, coordinate, and analyze a monitoring and experimental project to identify reference nutrient conditions, and determine threshold biological effects of nutrient enrichment in streams of the glaciated plains of Montana and North Dakota. Tt facilitated a workshop of local experts and state and EPA participants to develop the sampling and experimental design. Tt provided statistical guidance on project design including screening for site selection and guidance on statistical independence and power. Tt developed a screening methodology using a land use index of the relative alteration of natural land cover (natural vegetation to intensive cropland). Candidate sites were selected to span the gradient from natural to most heavily altered, so that water quality and biological response of streams to agricultural nutrient inputs could be examined. Tt prepared the Quality Assurance Project Plan (QAPP). Tt analyzed and interpreted data from the first year of the pilot study, and recommended modifications to the study plan. Tt is currently analyzing the final data set from the project to facilitate the development of regional-specific nutrient criteria. *Dates: April 2001 to Present.*
Florence Fulk EPA Office of Research and development Cincinnati, OH (513) 569-7379	Biological indexes developed by Tt and others require a variety of statistical tools to develop and calibrate the models. Tt is preparing a statistical methods guidance document targeted specifically at biomonitoring agencies of States and Tribes, to explain the statistical methods used, requirements for different methods, and guidance on selecting the most appropriate methods for the specific situation of an agency. Tt developed several alternative biological indexes using both univariate and multivariate approaches. These will be case study applications, using the same database, to guide readers through alternative approaches. Tt developed a workshop module to assist in the technology transfer, and has applied the module to teach personnel from several states. Tt prepared a draft for a workgroup consisting of technical experts and representative users of the guidance. *Dates: June 2001 to September 2002*

William Swietlick USEPA Office of Science and Technology Washington, DC (202) 566-1129	Tt assisted EPA Region 3, Division of Environmental Services (Wheeling, West Virginia) and the commonwealth of Virginia's Department of Environmental Quality (VDEQ), in developing biological criteria for assessing ecological health of the state's streams. Benthic macroinvertebrate data collected by VDEQ in non-coastal, 1st to 4th order streams during 1994-1998 were used to test whether different areas of the state should be classified into separate bioregions, each having relatively homogeneous natural composition of benthic macroinvertebrate populations in non-stressed, reference sites, but whose natural benthic communities would be recognizably different from other bioregions. Based on the data provided for these analyses, the non-coastal regions of Virginia were considered to be one bioregion. Recommendations were provided to assist the commonwealth in refining its regional reference conditions (bioregions), particularly as applied to previously under-sampled areas in the Piedmont. Tt calculated and aggregated numerical indicators of biological condition (metrics), based on USEPA's Rapid Bioassessment Protocols (1999 revision). The resultant index was calibrated with the Virginia data to be responsive to chemical and physical habitat indicators of environmental stress. The numerical multimetric index serves to 1) aggregate multiple characteristics of a site's biological community; 2) establish regional reference conditions; and 3) distill raw data to a single number, which then can be translated to narrative assessments of site conditions. Tt tested and confirmed response, variability, and utility of the index with new data collected by VDEQ. *Dates: March 1999 to March 2003.*

2.6.6 Company Profile and Experience

Our experience in performing statistical analysis of water quality data dates back to the opening of the Center for Water Resources office in 1976. We have performed many statistical analyses of large water quality data sets for EPA as well as many state environmental agencies. These analyses have been used in support of water quality standards promulgations, stressor identifications, and TMDL development. All work has been performed under the company name Tt, Inc.

This section provides biosketches for the key personnel who will provide primary support in this service category. Full resumes of all personnel described below are provided in Appendix A

Jeroen Gerritsen (Project Manager)
Dr. Gerritsen has more than 25 years of experience in aquatic environmental sciences, including basic and applied research, teaching, environmental assessment, and project management. His technical abilities include statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, stream ecology, and plant-nutrient relationships. He has directed multidisciplinary investigations and has contributed technical expertise to impact assessment and regulatory review, effects of acidic deposition, and design and analysis of environmental monitoring programs. He has broad field experience in lakes of North America and Europe; in streams, wetlands, and estuaries of the continental United States; and in the North Atlantic Ocean.

Clint Boschen
Mr. Boschen has more than seven years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He has supported Clean Water Act programs at the state and national level and is currently involved in TMDL development projects and biological assessment studies throughout the country. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. He routinely conducts watershed studies focusing on the assessment of biological condition in relation to pollutant levels and anthropogenic impacts. Mr. Boschen has experience in planning and conducting field monitoring studies, watershed characterization and modeling, wetland and stream corridor assessments, and water quality planning activities. His academic and research experience is in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

Henry Manguerra
Dr. Manguerra is a water resources/environmental engineer with more than 12 years of professional experience in the areas of watershed management, water quality modeling, nonpoint source pollution assessment, water supply allocation and optimization. His experience includes management and technical oversight of decision support systems, models, database, GIS and web development projects for various water resources and environmental applications. He has practical experience in all parts of the systems life cycle including the assessment of user requirements, system design, implementation, testing, quality assurance and deployment. He has successfully used and integrated diverse and emerging technologies in Internet development, GIS, database management, and computer programming. He has published numerous peer-reviewed technical papers and developed computer models and decision support systems related to his areas of expertise.

James Stribling
Dr. Stribling is an aquatic ecologist with 19 years of experience in applying ecological principles to water resource management decision making. He has been directly involved in developing field sampling and data analysis methods for the U. S. Environmental Protection Agency for the assessment of biological condition, physical habitat quality, and landscape integrity. He has developed approaches for evaluating the precision and accuracy of data used for biological assessments and overall quality assurance/quality control (QA/QC). Dr. Stribling has designed stream and watershed assessment programs for the examination of ecological condition based on biology, physical habitat quality, the presence (or absence) and relative intensity of human activities, and the role those activities play in influencing ecological condition. He is also currently involved in sample design and data analysis for Georgia and Mississippi. He has authored over 30 environmental studies and reports that have focused on the ecological effects of surface coal mining, agricultural and urban stormwater discharges, hazardous waste sites, environmental responses to physical habitat restoration, accidental spills of industrial chemicals, paper mill effluent, transportation facilities, regulatory compliance, combined sewer overflows (CSO), and urban and suburban development.

Julie Tsatsaros
Ms. Tsatsaros is a Senior Environmental Scientist with ten years experience in the environmental field focusing on all aspects of surface water quality, watershed, and assessments and studies. Ms. Tsatsaros has over five years of Total Maximum Daily Load (TMDL) experience. She has an extensive background in designing, implementing, and conducting fieldwork and sampling. She also has a strong laboratory background. Ms. Tsatsaros has experience consulting with State/Tribal/Federal agencies, as well as research-oriented studies. A former employee of the New Mexico Environment Department (NMED), she is familiar with western water quality issues, and the complex issues found in this region.

Lei Zheng
Dr. Zheng is a research scientist with extensive experience in the field of aquatic ecology and ecological statistics. He has participated in a wide range of multi-disciplinary investigations and research projects, which focus predominantly on the biological assessment of aquatic systems. His strong background in multivariate statistical analysis has helped to integrate complicated information into simple models and matrices for a

variety of projects. Dr. Zheng's research is towards developing diagnostics (identifying causes) for biological impairment. He has applied statistical modeling technique to identify the cause of impairment. As an expert on periphyton identification and data analyses, Dr. Zheng has used innovative approaches to develop nutrient and biological criteria for biological impairment. Dr. Zheng possesses technical abilities including but not limited to statistical design and analyses, wetlands ecology, stream ecology, and periphyton-nutrient relationships, and extensive experience in developing indicators for ecological impairment in aquatic systems.

2.6.7 Method of Providing Services and Quality Assurance

A recent project completed for the Virginia Department of Environmental Quality (DEQ) is an example of the approach we use to perform statistical analyses related to water quality. Virginia DEQ has conducted qualitative and semi-quantitative biological monitoring since the early 1970s, and has been using USEPA's 1989 Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989), with modifications, since 1990 (VDEQ 2000). The purpose of this study was to develop a multimetric biological index calibrated from Virginia data for use in assessment of Virginia streams. State stream assessment data from 1994 through 1998 were used to test for possible bioregion classifications and to develop the index.

Analytical Methods

Tt's analytical approach in this project generally followed the steps used in similar efforts in other states and regions (e.g., Barbour et al. 1996, Smith and Voshell 1997, Stribling et al. 1998, Gerritsen et al. 2000, Maxted et al. 2000). This approach proceeded through a general stepwise framework as follows, but was an iterative process in which steps three through five overlapped and were revisited throughout the process.

Steps in Biological Index Development
1) Develop the database
2) Identify reference criteria and reference sites
3) Determine site classification strata
4) Examine potential metrics for responsiveness
5) Aggregate responsive metrics into a condition

Virginia biomonitoring data

Tt obtained historic data from the Virginia DEQ biological monitoring program's database (BIOMON), consisting of benthic macroinvertebrate, physical habitat, and basic water chemistry data collected from 1994 through 1998. The data include a variety of site types and studies, ranging from special studies for which a site was sampled only once during the five-year period, to a regular network of sites where samples were collected twice per year (targeted for Spring and Fall). Data were transferred into a custom data management system called EDAS (Ecological Data Application System, version 2.1) (Tt 1999), developed for use with Microsoft Access®. In EDAS, data, metadata, and other information reside in a series of relational tables. Custom-designed queries have been built into EDAS to calculate and export biological metrics and other information for further analysis.

Tt instituted a comprehensive QC review of Virginia's historic data. Consultation with DEQ personnel provided valuable data quality review and database revisions in a number of areas. Geographic data (latitudes and longitudes) and stream order designations were obtained for many stations (incomplete in BIOMON), and incorrect entries were updated.

Sampling sites that originally had been entered into BIOMON under multiple site codes were identified and corrected so as not to be counted as different sites in the data set, and their corresponding habitat, water quality, and macroinvertebrate data were reconciled. Because the original BIOMON database placed zeroes in its habitat and chemical data tables if no values were entered (Seivard 1999, personal communication), all such zero-value data were treated as missing values. Some taxa tolerance values and functional feeding group designations were provided in BIOMON, and these were verified and supplemented (where absent) by consulting DEQ biologists, Merritt and Cummins 1996, Barbour et al. 1999, and professional judgment of the Tt project team.

Reference criteria and sites

Reference sites used in this analysis were identified two ways: by professional judgment of Virginia DEQ biologists; and by objective criteria applied to the data. Sites identified by either process were expected to be representative of least-impaired, best available, non-biological stream conditions. Virginia DEQ regional biologists submitted an initial set of candidate reference sites for their respective administrative regions based on their professional judgment and experience in those regions. Second, and separately, the following non-biological reference selection criteria was applied to individual samples in the database:

- Dissolved oxygen $ 6.0 mg/L
- pH between 6.0 and 9.0 (inclusive)
- Conductivity <500 umhos/cm
- Epifaunal substrate score $ 11
- Channel alteration score $11
- Sediment deposition score $ 11
- Bank disruptive pressure score $11
- Riparian vegetation zone width score $ 6
- Total habitat score $ 120

The criteria were applied on a per-sample basis to the data, and candidate reference sites were chosen by evaluating how consistently samples from each site met all of the above reference selection criteria. Further review of candidate reference sites was based on watershed land cover data provided by the EPA Region 3 office in Wheeling, West Virginia, based on 1:100,000 scale digital elevation models for Virginia and Multi-Resolution Land Cover data. In addition, reference sites were located only on first to fourth order streams.

A final set of 62 reference sites was identified, composed of sites from each of the selection methods and each having from one to ten samples over the five-year, 1994-1998, data period. Samples from the same site but collected in different seasons were treated as separate observations, so that the total number of observations in reference sites was 247 samples.

Site classification

Aquatic biological systems across a geographic range vary naturally in composition and diversity of fauna depending on inherent differences in natural factors such as the geomorphology and physico-chemical characteristics of watersheds in which the organisms reside. Partitioning this natural variability into relatively homogenous classes can aid in establishing reference conditions for the macroinvertebrate community.

In addition to natural factors, sampling and design artifacts may confound our ability to develop reliable natural classification of sites. Tt examined six alternative classifications:

- <u>Stream order</u>
- Ecoregion and subecoregion
- Alkalinity and stream gradient
- Season of sampling,
- <u>Reference selection criteria</u>
- <u>VDEQ administrative region</u>

Alternative classifications of reference sites were explored using statistical techniques known as ordination. Ordination analysis is a means of reducing the complexity of data so that it can be visualized graphically and examined with more conventional exploratory analysis.

For the Virginia data, we used non-metric multidimensional scaling (NMS). This method has been shown to be robust for ordination of species composition (e.g., Kenkel and Orloci 1986, Ludwig and Reynolds 1988) and has been used successfully for classification of stream communities (e.g., Barbour et al. 1996, Gerritsen et al. 2000, Reynoldson et al. 1997). The NMS ordination (McCune and Mefford 1995) follows the procedure of

Kruskal (1964). The final ordination was required to have a stress coefficient (a measure of goodness-of-fit of the ordination to the original data) of less than 20%. This usually required three ordination axes. The final NMS configuration was plotted as a scatterplot to determine any obvious groupings and to evaluate alternative classes. Separate scatterplots were examined for each of these six alternative classification groupings: ecoregions, conductivity/gradient groupings, index period, reference-selection-type, stream order, and DEQ administrative region. Classifications suggested by the scatterplots were explored using boxplots of metrics calculated separately and representing various specific attributes of the benthic community in each sample.

Metrics

Macroinvertebrate data (taxa identifications and counts) from each reference sample were used to calculate 30 different biological metrics. Metrics are numeric measures that quantitatively characterize different attributes of the macroinvertebrate community. The attributes of the community that are measured by these metrics fall into several categories of benthic community characteristics, and the specific metrics within those categories can indicate different aspects of community condition (see text box below). For example, metrics dealing with taxonomic richness, such as Total Taxa, can be used as indicators of community health because an ecologically healthy system is generally expected to support a greater diversity of fauna than can be supported in an ecologically impaired area. Multiple metrics evaluated together can give an overall indication of ecological integrity.

The 30 specific metrics calculated from Virginia data represent each of the categories described in this text box except for habit. Although habit metrics have been used successfully in many studies, we considered them to be unreliable for family-level data, because in many cases different genera within the same family have different habits.

As defined above, a metric is expected to change in some predictable way as disturbance or impairment in a watershed increases. The best candidate metrics for use in bioassessment are those that can differentiate between least-impaired and most-impaired streams. Using *a priori* sets of sites and samples representing least-impaired and most-impaired non-biological conditions (physical habitat and chemical water quality), we looked for metrics that best measured a difference in the biological communities corresponding to those two types of site conditions.

Using the same parameters as had been used to identify reference samples, we applied the following criteria to identify samples from the Virginia data whose physical and/or chemical quality could be considered stressed.

- Dissolved oxygen < 4.0 mg/L
- pH < 4.0
- Conductivity > 1000 umhos/cm
- Total habitat score < 120, and one or more of the following:
  - Epifaunal substrate score < 7
  - Channel alteration score < 7
  - Sediment deposition score < 7
  - Bank disruptive pressure score < 7
  - Riparian vegetation zone width score < 4

To be labeled as stressed, a sample needed to meet only one of the listed conditions. Using these criteria, 71 samples from 25 sites were identified as stressed.

Box-and-whisker plots were used to display distributions and ranges of values of the metrics between stream-quality categories (reference and stressed samples). This type of plot displays the statistics of median value, minimum value, maximum value, and 25th and 75th percentile values of a population of data.

The ability of a metric to discriminate between least-disturbed (reference) and most-disturbed (stressed) samples is based on the degree to which the metric boxplot in reference samples differs from the same metric's boxplot in stressed samples. If the interquartile range (IQR) of values in reference samples is completely within the IQR of values in stressed samples, and the medians of each range are not very different. The metric does not differentiate well between the two populations of samples. In contrast, if there is no overlap between the interquartile ranges of the reference and stressed samples, and the median of either population of samples is well outside the IQR of the other population of samples. This metric differentiates more clearly between the reference and stressed populations of samples.

Index development

To obtain an overall measure of ecological integrity, multiple metrics were combined to provide a single multimetric index of biotic integrity. This index provides a single numeric assessment value that combines information from different types of biological information. In addition to selecting individual metrics that (1) can discriminate clearly between least-stressed and most-stressed conditions, metrics should (2) represent at least several different aspects of the biotic community (e.g., composition, richness, diversity, tolerance, trophic groups), and (3) minimize redundancy among individual component metrics. To test for redundancy, we performed a Pearson correlation analysis on metrics calculated from the Virginia data. Metrics that are highly correlated measure the same thing and should not be used together to determine impairment. The process of metric selection was iterative, with these areas of consideration being revisited and weighed through the process.

Once metrics were selected for use in a multimetric index, the metric values were converted to unitless scores, and then the individual metric scores were averaged into a single numerical index value. To score the metrics, the range of values for each metric was standardized to a consistent 100-point scale, assigning all metric values a proportional score ranging from 0 (worst) to 100 (best). The specific scoring procedure used for achieving the 100-point scoring range differed depending on whether an individual metric's values increased or decreased with greater environmental disturbance.
By standardizing the metric values to a common 100-point scale, each of the metrics contributed to the combined index with equal weight, and all of the metric scores represented increasingly better site conditions as scores increased toward 100. Once all metric values for sites were converted to scores on the 100-point scale, a single multimetric site index score was calculated by simply averaging the individual unitless metric scores for the sample.

Test of Index With Independent Data

Virginia DEQ provided additional data, collected from Spring 1999 through Spring 2002, with which we tested the stream condition index. For the working index to be valid, it should separate *a priori* reference from stressed sites in the new data as well as it did in the original data that were used to develop the index.
The 1999-2002 validation data consisted of sites that were sampled various numbers of times, ranging from only one sample per site up to seven samples per site (e.g., spring and fall each year from Spring 1999 through Spring 2002). Basic field water quality data and RBP physical habitat data again were recorded for each sample at the time of macroinvertebrate collection for most samples. The new data set consists of 733 samples collected at 263 stations on non-coastal streams of stream orders 1-4. Candidate reference and stressed sites in the new data set were identified using non-biological criteria as in the original data set.

Revising the Index (SCI)

The Draft Virginia macroinvertebrate stream condition index (SCI) in 1999-2002 test data showed good separation between *a priori* reference and stressed sites, as it did in 1994-1998 development data. Subsequently, all samples were combined to refine the working index and make use of the entire 19942002 data set. Percentile distributions of each metric's values were determined for the entire data set (n=1671 samples). The 95th or 5th percentile standard "best" values were determined for each benthic metric from this combined set of all samples. Differences between the Draft and Revised standard percentile values are small, indicating stability of these metrics in the Virginia data set.

Table 2-17. Comparison of standard metric values in development data vs. test data.

	1994-1998 development data (n=938 samples)	1994-2002 combined data (n=1671 samples)
Metrics that decrease with stress	Standard (best value) X_{95}	
Total taxa	22	22
EPT taxa	11	11
%Ephemeroptera	58.9	61.3
% Plec+Tric less Hydropsych.	34.8	35.6
% Scrapers	49.1	51.6
Metrics that increase with stress	Standard (best value) X_5	
% Chironomidae	0	0
% Top 2 Dominant	29.5	30.8
HBI (family)	3.2	3.2

Index Variability

The Virginia macroinvertebrate data set included many sites that had been visited multiple times, twice per year (spring and fall index periods) for up to ten years. These data allowed us to estimate variability among seasons, between consecutive years (same season), and among multiple years. These components of variability could be compared to the overall variability among all sites in the data set. The estimated standard deviations are shown in Table 2-18.

Table 2-18 shows that the fall index period results in the lowest variability of SCI values (s.d. of 5.88 SCI units for observations 1 year apart). The spring index period had slightly higher variability (s.d = 8.21 units). The variability among sites within ecoregions is only slightly higher (s.d. = 9.75 units). These yield coefficients of variation of 8-12% for the variability of single observations at sites. These estimates are all components of natural variability: seasonal, multi year, multi site, and ecoregional. We were not able to estimate variability due to measurement error (methodological variability), which would require repeated samples during a sampling event. The variability estimates shown in Table 2-18 indicate that index values within sites are relatively stable among seasons and among years.

Table 2-18. Estimated standard deviation of Virginia SCI, based on repeated observations within sites.

Category	**n**	**s.d.**	**Ref. mean**	**C.V. (%)**[1]	**Notes**
Between Season	235	8.65	68.8	12.6	Within-site; all spring-fall observations within single year
1 yr, fall	205	5.88	69.4	8.5	Within-site; all fall observations 1 year apart
all fall	264	6.64	69.4	9.6	Within-site; all fall observations (1-5 yr)
all spring	190	8.21	68.2	12.0	Within-site; all spring observations (1-5 yr)
fall site means within ecoregion	88	9.75	n.a.	n.a.	Among sites within ecoregion; site means, fall, reference sites only
ecoregion	4	11.35	n.a.	n.a.	Among ecoregions, fall, reference sites

C.V. based on mean of reference sites, although s.d. was estimated for all sites

2.6.8 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Dr. Jeroen Gerritsen, is provided above.

Table 2-19. Staff qualifications for service category 3.5.13 (Statistical Analysis).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Clint Boschen	M.S.	Biological Sciences	Yes	7/7	101.72
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
Jeroen Gerritsen	Ph.D.	Ecology and Evolutionary Biology	Yes	25/25	140.70
Jason Gildea	M.S.	Environmental Science and Engineering	Yes	5/5	64.35
Kirk Gregory	Ph.D.	Geography	Yes	9/9	83.43
Henry Manguerra	Ph.D.	Bioresource Engineering	Yes	12/12	154.64
James Stribling	Ph.D.	Entomology	Yes	19/19	121.22
Julie Tsatsaros	M.S.	Limnology	Yes	10/10	92.13
Lei Zheng	Ph.D.	Ecology, Evolutionary Biology, and Behavior	Yes	16/16	77.92

2.7 Service Category 3.5.21: Communication/Educational Services – Information Transfer & TMDL Technical Editing

Over the past 20 years, Tt has developed hundreds of printed outreach products, displays, slide presentations, graphics, and web sites for states, tribes, US EPA, the U.S. Army Corps of Engineers, and other clients nationwide. Tt's experience in developing the analytical tools, documentation, education, and public involvement necessary for successful TMDL work is unsurpassed. The breadth of Tt's experience in TMDL education, outreach, and public involvement includes development of on-site training programs, summary documents, and web training modules, in addition to many scientific and technical products.

2.7.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references.

Table 2-20. References associated with Service Category 3.5.21 (Information Transfer and TMDL Technical Editing).

Reference Information	Description of Service
William Painter US EPA HQ OWOW 1200 Pennsylvania Ave NW Washington, DC (202) 566-1218	Tt supported development and delivery of two training programs for the Office of Wetlands, Oceans, and Watersheds: *The ABCs of TMDLs*, a two-day workshop for novice/intermediate level staff focusing on the TMDL program; and The Clean Water Act and Other Tools for Watershed Protection, a two-day workshop for upper level staff with detailed information on water quality standards, NPDES permitting, TMDLs, and all other aspects of Clean Water Act provisions. Deliverables included all slide presentations, handouts, and delivery of workshop sessions to agency personnel, private sector attendees, and the public. The course has been developed as a 61-slide interactive, web-based training module, posted on the US EPA Watershed Academy Internet site. *Dates: November 2000 to Present*
Kevin Faulkenberry CA Dept of Water Resources San Joaquin River Management Program Fresno, CA (559) 230-3320	Working with the California Department of Water Resources, California State University, and other state/federal agencies, Tt developed and delivered four week-long training courses under the "Working at a Watershed Level" curriculum developed by NRCS, USFS, USBR, USEPA, USFWS, and other agencies. Tt identified in-house and external presenters, developed slide presentations, delivered workshop sessions, led field trips, and provided logistical support in partnership with California State University. Course topics ranged from fluvial geomorphology and biological assessment approaches to public outreach and involvement. *Dates: January 1999 to February 2002*.

Rod Frederick US EPA Office of Water Washington DC (202) 566-1197	Tt produced the new Onsite Wastewater Treatment Systems Design Manual, including reviewing the existing manual, collecting information on onsite wastewater treatment technologies and management approaches, and producing the new national design manual published by EPA in 2002. Tt reviewed and summarized technical studies on treatment system performance and included information on innovative programs and approaches for managing existing and new systems. Tt provided case study examples, sample problems to assist in system design and management, and information on system performance, design criteria, O&M requirements, and costs. *Dates: September 1999 to August 2002.*
Corrine Wells Kentucky Division of Water Frankfort, KY (502) 564-3410	Tt developed and delivered a series of 25 statewide workshops on erosion and sediment control principles and practices for new construction sites and produced a new statewide Field Guide and Technical Manual for construction industry and engineering professionals. Documents produced featured full color graphics and original photos, new summary tables of BMP design and installation details, and laminated pages throughout for durability. *Dates: June 2001 to present.*
Paul Braasch Office of Environmental Quality Batavia, OH (513) 732-7745	For Clermont County, Ohio Tt has facilitated a variety of public outreach efforts within the watershed. Activities have included watershed training workshops, scientific advisory committee meetings, stakeholder meetings, and development of "report cards" that summarize the condition of the watershed for a non-technical audience. Dates: *January 2002 to July 2002.*
John Koches Annis Water Resources Inst. Grand Valley State University Muskegon, MI (616) 895-3792	Tt conducted training workshops and provided support for a wide range of activities, including outreach and education, partnering with the news media, stakeholder involvement, stormwater management and program development, and watershed planning. Working with a group of elected officials, technical staff, and the public, Tt conducted research, developed outreach and education plans, supported model ordinance development, facilitated public meetings, developed watershed management plans, and provided training on onsite wastewater treatment. *Dates: March 1997 to present*.

2.7.2 Company Profile and Experience

Tt is widely respected – and appreciated – as a contracting firm that can execute rapid, accurate, and high-quality turnaround on product development and production. Tt technical and outreach product development staff work closely with Tt graphic artists and production personnel throughout the project period to ensure timely responses and first-rate work. All of Tt's technical, outreach, and production staff are located in the same building in the Washington DC area. The Tt Fairfax Office production department has the full range of technical and production tools and equipment to quickly develop draft products, incorporate edits, produce large posters, and generate print-ready files for publication.

Tt has demonstrated its commitment to completing projects on a timely basis by:

- Producing on short notice display booth posters, brochures, fact sheets, booklets, promotional items, and other materials EPA's Year of Clean Water Celebration (Watershed Month, Wastewater Month, Storm Water Month, and Nonpoint Source Month).
- Publishing EPA's Annual Report and two editions of Liquid Assets, the second of which was produced in 30 days.
- Composing chapter drafts for the Onsite Wastewater Treatment Systems Manual and incorporating edits for quick turnaround reviews by numerous technical reviewers and EPA staff across the country.
- Developing the third volume of EPA's 319 Success Stories, which required working with all EPA Regional Offices and collecting information from state programs.
- Incorporating edits on short notice to EPA Watershed Academy online training modules.

This section provides biosketches for the key personnel who will provide primary support in this service category. Many of our other TMDL specialists also have experience in the identification of TMDL targets. Full resumes of all personnel are provided in Appendix A.

Melissa DeSantis (Project Manager)
Melissa DeSantis is a public outreach specialist with more than 8 years of professional experience. She leads the public outreach department in Tt's Fairfax, Virginia, office. She currently manages projects providing environmental education and public outreach services for the U.S. Army Corps of Engineers (Mobile District), the U.S. Environmental Protection Agency, and state and local agencies. The majority of her work has focused on watershed and water pollution prevention education and outreach. She has developed numerous outreach materials including newsletters, web sites, posters, slide shows, multimedia computer demonstrations, fact sheets, calendars, brochures, citizen guides. She has also coordinated multiple public meetings, conferences, training workshops, and stakeholder focus groups.

Kellie DuBay
Ms. DuBay has supported projects for the U.S. Environmental Protection Agency, including the Office of Wastewater Management, the Office of Policy and Reinvention, and the Chesapeake Bay Program, as well as state and local clients. In working for these various clients, she has participated in projects both regulatory and nonregulatory in nature. Ms. DuBay's work focuses on analyzing, synthesizing, and delivering technical and regulatory information using a variety of mechanisms tailored to specific audiences. These audiences include agency staff, the regulated community, and the public. She has knowledge and experience in the areas of Phase I and II NPDES storm water permitting, and is supporting EPA's recent initiative to promote watershed based NPDES permitting.

Jessica Koenig
Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Barry Tonning
Mr. Tonning is a senior analyst specializing in environmental management, risk assessment and communication, public health issues, and technology transfer with extensive experience in policy development and program design for watershed assessment, planning, and management projects. Over the past 25 years he has directed and managed onsite wastewater and nonpoint source pollution assessment and control projects; environmental and natural resource policy research initiatives, solid waste planning and management programs; watershed training courses; the publication of environmental management guidance documents; and the development, coordination, and facilitation of public meetings, conferences, and workshops on a wide variety of environmental, public health, and natural resource topics.

Partial List of Outreach Materials Produced by Tetra Tech: 1998 – 2004

Client	Outreach Product
U.S. EPA OWOW/AWPD	▪ Getting In Step: Engaging and Involving Stakeholders in Your Watershed ▪ Help Your Watershed Poster and Bookmark for Water Monitoring Month ▪ Outreach Materials for Nonpoint Source Month: 4 posters; bookmark; pop-up sponge; crossword puzzle placemat; folders; urban and agricultural NPS fact sheets; 2 brochures ▪ Liquid Assets 2000: America's Water Resources at a Turning Point (2000) ▪ Liquid Assets: A Summertime Perspective on the Importance of Clean Water to the Nation's

	Economy (1996) · Nonpoint Source News-Notes · Tribal Nonpoint Source Planning Handbook · Catalog of Federal Funding Sources · Ship shape Shores and Waters: A Handbook for Marina Operators and Recreational · Community Culture and the Environment: A Guide to Understanding a Sense of Place · Getting In Step: A Guide to Effective Outreach In Your Watershed · Section 319 Success Stories, Volume III · Two Watershed Academy Web Posters · Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico
U.S. EPA OWM and OWOW/AWPD	Brochure: After the Storm: A Citizen's Guide to Understanding Stormwater Make Your Home The Solution to Stormwater Pollution: A Homeowner's Guide to Healthy Habits for Clean Water
U.S. EPA OWM	A Homeowner's Guide to Septic Systems Brochure: Where Does All the Dirty Water Go?
U.S. EPA OCFO/OPAA	EPA's Fiscal Year Annual Reports for FYs 2001 and 2002
U.S. EPA Wetlands Division	Poster on the Functions and Values of Wetlands Tribal Wetland Program Highlights Wetland Fact Sheet Series: Wetlands Overview; Types of Wetlands; Functions and Values of Wetlands; Threats to Wetlands; Wetland Restoration; Funding Wetland Projects; Wetlands Program Development Grants; Wetland Monitoring and Assessment; Teaching About Wetlands; Sustainable Communities; Volunteering for Wetlands
USMC Logistics Base	Brochure and kid's activity sheet on Indian Lake Wildlife Refuge
Delaware DNREC	Brochure: Delaware's Riparian Buffers: Building A Line of Defense to Protect Our State's Waters
DE Estuary Program	12-month color calendar focusing on watershed protection
Rockdale County, GA	Watershed newspaper insert on watershed assessment and plan
Chesapeake Local Assistance Department	Brochure: Working to Protect Stream, Rivers, and the Bay

2.7.3 Method of Providing Services and Quality Assurance

Outreach and education are two key components of both internal (agency-wide) and external (outside partners and the public) TMDL support. Tt wrote and designed two of US EPA's leading documents on outreach, education, and stakeholder involvement. Getting In Step: A Guide to Effective Outreach in Your Watershed provides many of the tools needed to develop and implement an effective watershed outreach plan. The outreach guide is a manifestation of the content presented in watershed outreach training workshops conducted throughout the country. Tt has conducted more than 80 training workshops across the United States for federal, state, and local officials on a variety of public involvement topics, such as TMDL training, developing an effective public involvement strategy, creating eye-catching outreach materials, working with stakeholders, resolving conflicts, building agreements, and partnering with the news media to disseminate a message. Tt recently wrote the companion guide Getting In Step: A Guide to Engaging and Involving Stakeholders in Your Watershed. This stakeholder involvement guide presents a step-by-step approach to educate watershed managers on how to effectively work with communities to get environmental results. It covers how to get started, outreach and communication tools for working in the watershed, identifying and recruiting stakeholders from the community, tips for working with stakeholders, and implementing desired actions.

To help address information, education, and outreach needs, the states (under the Association of State and Interstate Water Pollution Control Administrators) and EPA have formed a Nonpoint Source Information Transfer and Outreach Workgroup. The mission of the Workgroup is to raise public awareness while generating positive behavioral changes regarding NPS problems and solutions. Tt supported this effort by creating a toolbox that can be distributed to the states and then made available to local watershed communities for their use.

The toolbox offers strategies for changing personal behaviors that contribute to NPS pollution, focusing on what people can do around the home to prevent NPS pollution (i.e., personal stewardship). The toolbox will contain a how-to guide for launching a local NPS pollution outreach campaign, a CD-ROM of sample materials or templates in various formats that could be used and easily tailored to the community's local problems and barriers to adopting better habits, a Web site to house the materials, and a searchable on-line database to serve as a clearinghouse for NPS media campaign materials already in use across the country.

Tt also developed a comprehensive public involvement plan to encourage public participation in the development of an Environmental Impact Statement (EIS) for Lake Lanier. The plan is being implemented in four phases. Phase 1 was designed to establish initial contact with the local stakeholders and raise awareness about the development of the EIS. This phase included a media campaign that involved preparation and distribution of informational brochures at the public meetings, and display ads, news releases, and public service announcements to the local newspapers, radio stations, and television stations. A Web site also was developed as another mechanism of disseminating information, and as vehicle for submitting comments electronically. Information on the public meetings, management activities, media information, and the meeting brochures were archived on the Web site. Phase 2 involved arranging the logistics for the public meetings to solicit input from agencies and the public regarding the range of issues and reasonable alternatives to be addressed during the EIS process. In addition to the public meetings, four focus group meetings were held to solicit input from target audiences that live around or recreate at the lake. The focus group participants were randomly selected using a database that included environmental organizations, business owners and operators, lake-area users, and recreational users of Lake Lanier. Reports summarizing the results of the public meetings and the focus group meetings were made available to the public at designated repositories in the community

Tt also works with a number of state water resource programs. For example, Tt is developing an Antidegradation Implementation Procedure for the Arizona Department of Environmental Quality through an internal workgroup and producing the final technical document. Tt has supported Delaware's Coastal Programs for many years under various contracts. For the Delaware River Basin Commission, Tt developed a regional public outreach strategy to control nonpoint source pollution for Pennsylvania, New Jersey, and Delaware as part of their Coastal Nonpoint Pollution Control Programs. Outreach products included a life-size write-and-wipe crossword puzzle on watershed issues, coloring sheets for kids, tote bags, septic tank-related magnets, a public survey to gather baseline information on people's knowledge of NPS pollution, several fact sheets on specific areas of NPS pollution targeted to homeowners, a watershed calendar, and a slide show on NPS pollution. Tt also assisted Delaware in updating the state's Coastal Zone Management Program outreach document, which incorporates photographs and pull quotes and uses desktop publishing techniques to create a visually appealing product while satisfying the requirements of the Coastal Zone Management Act. Tt edited the document to ensure technical consistency with Coastal Zone Management Act requirements, uniform tone, and grammatical accuracy.

Tt developed a comprehensive, 5-year outreach strategy to promote community management of onsite wastewater treatment systems (OWTS). Tt is now in the third year of implementation and has provided logistical support for a national meeting and numerous workgroup meetings; developed and maintained a Web site (www.epa.gov/owm/mtb/decent/index.htm); managed EPA's decentralized listserver; provided logistical support and developed materials for a speaker's bureau to promote OWTS management; developed abstracts and presentations for national and statewide conferences and workshops; wrote and distributed press releases on the status of EPA's Voluntary Management Guidelines on the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems; created and distributed more than 3,000 informational packets; maintained a database of stakeholders; developed fact sheets on EPA's onsite program, various documents available on OWTS management, and a homeowner's guide to septic systems; and created a poster describing the Guidelines and give-aways to promote the program. Tt continues to maintain the program's Web site, listserver, and database; assembles and distributes informational packets; and develops fact sheets as needed.

Tt created a multimedia presentation in Microsoft PowerPoint that showcased several US EPA Office of Water web sites, including EMPACT, the Watershed Information Network, the Index of Watershed Indicators, Adopt Your Watershed, and American Heritage Rivers. The purpose of the presentation was to demonstrate to the public how they could use EPA's web-based resources to protect their local water quality. It answered the following questions: What is my watershed address? How healthy is my watershed? How can I get involved? What resources are available? The presentation included narration, music, and animation and operated on a loop so that it could be run continuously on a laptop at various EPA conferences and events. Tt hired a professional reporter with National Public Radio to narrate the presentation and recorded the narrative at a sound studio. Tt also selected and edited copyright-free music to accompany the narrative. In addition, Tt created an attractive 5-foot by 3-foot laminated poster for use when the presentation is exhibited. EPA continues to use the presentation at meeting and conferences.

Other water resource outreach programs supported by Tt include the Watershed Academy, an interactive, web-based US EPA training program designed to educate technical staff and watershed managers at all levels of government and in the private sector on using the watershed approach and related technical tools. Tt provides technical and logistical support for course development, watershed-related publications, statewide watershed management facilitation, and other training materials. The Academy covers a variety of watershed topics ranging from scientific methods (e.g., biological, chemical, physical) for watershed assessment to more qualitative approaches to stakeholder involvement, outreach, education, and management practice implementation. Tt has assisted in developing many of these courses and has provided support for delivering the course in multiple formats (Web-based, classroom delivery, printed materials). For example, Tt supported the development and delivery of new courses entitled Working at a Watershed Level, A Framework for Stream Corridor Restoration, Getting In Step: A Pathway to Effective Outreach in the Watershed, and BASINS: A Powerful Tool for Managing Watersheds. Tt has also helped to improve the speed and quality of graphics and software used to enhance the educational value of the free, Web-based, self-paced training modules. Tt is currently developing a new course that merges outreach/education components with TMDL training in an effort to improve TMDL implementation in the states and on tribal lands. To supplement the online course, Tt has conducted more than 75 workshops, week-long courses, and presentations on Watershed Academy topics during the past 5 years, supported by federal, state, local, and private funding. The on-line Getting in Step outreach guide and the Web-based Stream Corridor Restoration graphics package have been accessed by thousands of users for educational purposes or to supplement workshops and training courses at remote locations nationwide.

2.7.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Ms. Melissa DeSantis, is provided above.

Table 2-21. Staff qualifications for service category 3.5.21 (Communication/Education).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Melissa DeSantis	B.S.	Environmental Science	Yes	8/8	92.13
Kellie DuBay	B.S.	Environmental Policy	Yes	5/5	82.26
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Barry Tonning	B.A.	Journalism	No	25/25	116.49

2.8 Service Category 3.5.23: Preparation of Technical Manuals or Circulars

Tt has extensive experience preparing technical guidance manuals related to the management of water resource issues. Although most of our older work in this area has been for EPA, more recently we have been completing more customized manuals for state agencies.

2.8.1 References

We feel that one of the best indicators of our ability to delivery quality products in a timely and cost effective manner are the references and testimonials from former and current clients for whom similar work was conducted. We have provided the contact information for the following projects related to this service category and we would encourage DEQ to contact these references.

Table 2-22. Summary of references for Service Category 3.5.23: Preparation of Technical Manuals or Circulars.

Reference Information	Description of Service
Tom Mumley San Francisco Bay Regional Water Quality Control Board San Francisco, CA (510) 622-2395	The process of addressing impaired waters in California is conducted by the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) through actions that are consistent with both national and regional USEPA regulations and guidance as well as state technical, regulatory, and legislative requirements. Tt developed a comprehensive guidance document for the SWRCB to facilitate the process of addressing the complex programmatic and technical needs of managing impaired waters. This guidance was also designed to facilitate a greater understanding of expectations, which will result in improved coordination, consistency, and information exchange among state agencies and the public. The document reflects California's process for responding to an impairment listing, recognizing a series of project phases. The phases range from defining and planning the project to data collection and analyses to regulatory action and implementation. The guidance document provides a description of these phases along with decision-making tools and examples needed to identify actions that will lead to improvement of waterbody conditions and ultimate removal of the impaired water designation. The iterative decision process presented in this document provides opportunity at each phase to consider the most appropriate response to the impairment listing, such as review and revision of applicable water quality standards, establishing a TMDL, or other regulatory action. This guidance also reaffirms that most if not all of the process for addressing waters that do not meet applicable standards can be accomplished through existing regulatory tools and mechanisms. In addition to the main guidance document, Tt is developing companion technical modules for developing TMDLs for specific pollutants. Tt has developed a module for bacteria providing comprehensive guidance and "how-to" information on all aspects of developing bacteria TMDLs in California. Tt also developed several companion tools for the bacteria module, including spreadsheet tools to efficiently and easily organize and analyze water quality data for comparison to water quality objectives; facilitate hydrologic calibration; and to characterize potential bacteria sources. *Dates: 8/02 – ongoing*
Mimi Dannel USEPA Headquarters Washington, DC (202) 564-9944	Tt developed *Protocol for Developing Sediment TMDLs* (EPA 841-B-99-004), *Protocol for Developing Nutrient TMDLs* (EPA 841-B-99-007), and *Protocol for Developing Pathogen TMDLs* (EPA 841-R-00-002) to provide an organizational framework as well as technical background for establishing TMDLs for the most frequent causes of water quality impairment. The protocols provide programmatic and technical background and guidance on all aspects of the TMDL development process as related to the pollutants of concern, including characterization of the impairment; establishment of water quality endpoints and targets; identification and characterization of sources; linkage of source loadings to instream water quality response and water quality targets; allocation of loading capacity; implementation of TMDL allocations; and post-implementation monitoring. *Dates: October 1997 to January 2001*

Chris Laabs USEPA Office of Water Washington, DC (202) 566-1223	Under the direction of EPA's Watershed Branch, Tt developed the Compendium of Tools for Watershed Assessment and TMDL Development. The Compendium addresses the technical issues of developing and implementing TMDLs within a broader water quality-based management strategy. This approach sets the stage for state and federal agencies to establish both point and nonpoint source pollution controls on a watershed basis. The three-step process used to review existing watershed-scale models included model identification, model acquisition, and model documentation. Each model was categorized as simple, mid-range, or detailed based on a qualitative evaluation of its simulation capabilities, modeling performance, and ease of use. Tt's efforts were focused on EPA-supported models and simple models to facilitate the screening process for TMDL developers. The Compendium provides a description of each model that includes model components, methods, applications, pollutants addressed, limitations, input data requirements, and type of output. The document also contains information on model selection for specific applications, model calibration, and model verification. A chapter on ecological assessment techniques and models is also included. *Dates: 2/1991 to 5/1997*
Dr. Mow-Soung Cheng Prince George's County, MD 301-883-5810	Tt is the prime technical developer of the Prince George's County low-impact development guidance and design manuals. This ongoing effort has included the development of low-impact technology, design criteria, assessment methodologies, and design and analysis tools, building on Tt's experience gained in working on Prince George's County storm water management programs and on national and state programs. The low-impact development approach is a demonstration of how urban development can be designed, constructed, and maintained with minimal impact on the existing site ecosystem. The approach uses micromanagement-level planning and site development techniques to incorporate storm water management into a site's landscaping plan. The Prince George's County low-impact development approach presents a new perspective in urban development. It integrates site ecological and environmental requirements into all phases of urban planning and design, and it considers the implications of development on a broad scale ranging from the watershed to the individual residential lot. Prince George's County is currently analyzing design criteria to use this approach in residential land use development. Tt is assisting the county in the development of design and evaluation tools; detailed design criteria; and a "how to" manual for regulators and watershed planners, engineers, technicians, draftsmen, inspectors, plan reviewers, and landscape architects to use when proposing new development and retrofit designs. The two-part manual developed by Tt was later printed by the USEPA for national distribution. *Dates: 3/95-11/97*
Kent Patrick-Riley Alaska Department of Conservation Anchorage, AK (907) 269-7554	As part of their comprehensive TMDL support to the Alaska Department of Environmental Conservation (ADEC), Tt wrote *Technical Approach for Fecal Coliform Bacteria TMDLs in Alaska, which* provides customized guidance on developing pathogen TMDLs. Topics addressed in this guidance document include: factors affecting pathogen survival; pathogen source controls; methods to evaluate pathogen sampling data; methods to estimate pathogen loads from different sources; and technical approach options. The technical approach options include a “simple” approach that develops loads based on development of a flow duration curve and a “detailed” approach using SWMM. The need for this guidance was identified during a two-week TMDL training/consultation visit that Tt made to Anchorage and Juneau during the summer of 2000. *Dates: 12/99 - 7/00*

Jim Greenfield U.S. Environmental Protection Agency Region 4 (404) 562-9238	Tt developed a pathogen assessment and TMDL procedure to assist the Georgia Environmental Protection Department (EPD) in meeting court-imposed TMDL deadlines. The guidance document, *TMDL Procedure B-01 Fecal Coliform Bacteria Impairment*, is the first in a series of TMDL procedural guidelines targeted at different pollutants, including dissolved oxygen, metals, and toxicity. The pathogen procedure addresses TMDL development for flowing stream reaches where the impairment is caused either by nonpoint sources only or by a combination of point and nonpoint sources. It describes a series of analytical procedures and demonstrates necessary steps through an example TMDL using custom-developed assessment and modeling tools. The core of the custom tools is the Watershed Characterization System (WCS), which is a GIS-based analysis system containing TMDL-related analytical extensions and models. Other tools include spreadsheets to address important steps in the TMDL process, such as water quality observation data and impairment analysis, fecal coliform loading and model parameter estimation, and water quality calibration. The NPSM/HSPF model is currently being used for the procedure. Development of the procedure involved collaboration of key stakeholders, including the NRCS and the U.S. Forest Service, and has included technical training and continued technical support during the TMDL development process. *Dates: 9/99-6/00*
Paulette Ballard U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds (202) 566-1156	Tt prepared EPA's *Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls*, which presents methods for performing water quality, ecological, and NPS monitoring of physical, chemical, biological, and habitat parameters. The technical guidance includes recommendations for developing monitoring goals and objectives, variable selection, statistical design and evaluation, and quality assurance and control. The guide was written to provide practitioners and those who manage monitoring and evaluation projects a statistical means to link land-based management data with water quality through watershed-level and site-specific evaluations. Tt also developed three technical guidance documents that address implementation tracking of NPS pollution controls and prevention measures. The documents present methods to ensure the statistical validity of tracking and monitoring results, as well as guidelines for presenting the results of pollution management tracking and monitoring programs to decision makers so that the results are understood. Tt is currently supporting field testing of the urban guide. *Dates: 9/94 to present*
William Swietlick USEPA Office of Science and Technology Washington, DC (202) 566-1129	As prime technical contractor, the Tt team developed technical guidance documents for implementing biological monitoring for nonpoint source problems, assessing biological integrity, and developing biological criteria. These documents provide guidance to water resource agencies on methods for biological assessment in keeping with the goal of maintaining biological integrity of the nation's waters. Tt scientists, under the direction of EPA, were members of expert scientific workgroups that selected assessment tiers and approaches, sampling methodologies, and analytical methodologies for bioassessment in the following waterbody types: (1) *Biological Criteria: Technical Guidance for Streams and Small Rivers* (EPA 822/B-96/001); (2) *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition* (EPA 841/B-99/002); (3) *Lake and Reservoir Bioassessment and Biocriteria, Technical Guidance Document* (EPA 841/B-98/007); and (4) *Estuarine and Coastal Marine Waters Bioassessment and Biocriteria Technical Guidance (draft - 2000)*. Tt scientists were the primary technical authors of the guidance documents. These scientists addressed emerging technical issues, including selection of habitat, target assemblages, study design, habitat assessment, regionalization, and quality assurance. *Dates: 1/91 to present*

2.8.2 Company Profile and Experience

Within Tt, the Water Resources and TMDL Center headquartered in Fairfax, Virginia is the leader in providing technical and programmatic support for watershed and water quality studies, including the development of technical guidance documents. Our experience dates back to the opening of the Center for Water Resources office in 1976 and includes the significant milestones:

1979: Developed EPA wasteload allocation modeling guidance manual 1991: Developed EPA's first TMDL guidance document 1997: Developed EPA's *Compendium of Tools for Watershed Assessment and TMDL Development* 1999: Supported EPA's development of the nutrient and sediment TMDL protocols 2001: Developed EPA's pathogen TMDL protocol 2003: Developed *A Process for Addressing Impaired Waters in California*

This section provides biosketches for the key personnel who will provide primary support in this service category. We have many other specialists with extensive TMDL experience that cannot be shown due to the 20-person limit specified in the RFP. Full resumes of all personnel described below are provided in Appendix A.

Jessica Koenig (Project Manager)
Ms. Koenig is an environmental scientist with more than 7 years of experience providing programmatic and technical support for EPA's TMDL Program. In addition to developing numerous TMDLs, Ms. Koenig has provided extensive programmatic support for EPA through development of guidance documents for TMDL development (including EPA's Protocols for Developing Sediment, Nutrient and Pathogen TMDLs), support and coordination of meetings related to the TMDL program, and TMDL-related training and technology transfer. She has also provided technical and programmatic review of over 30 TMDLs and supported the response to public comments on the Proposed Revisions to the Water Quality Planning and Management Regulation (40 CFR Part 130, August 23, 1999). Ms. Koenig has managed and participated in the development of a variety of TMDLs, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. Ms. Koenig is currently the work assignment leader for technical support and development of TMDLs for EPA Region 10, including TMDLs in Idaho, Washington and Alaska for a range of pollutants (sediment, nutrients, DO, fecal coliform, debris and seafood residue).

Andrew Parker
Mr. Parker is an environmental engineer with 8 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development. He has managed or been a technical advisor on projects resulting in development of more than 2,000 TMDLs throughout the country for a range of issues, including bacteria, nutrients, dissolved oxygen, sediment, metals, temperature, and PCBs. He has worked on TMDL projects directly for numerous state, city, and territory environmental agencies, including Montana, Arizona, Oregon, California, Nevada, Utah, Texas, Nebraska, Minnesota, Maine, Massachusetts, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, West Virginia, Kentucky, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Puerto Rico, and the U.S. Virgin Islands, as well as all 10 EPA Regions. He has been a key contributor to development of advanced environmental modeling systems, including EPA OST's BASINS, EPA Region 4's TMDL Toolbox, and EPA Region 3's Mining Data Analysis System (MDAS). Mr. Parker also has extensive experience applying hydrologic and water quality models of varying complexity, including HSPF, GWLF, SWMM, LSPC, EFDC, CE-QUAL-W2, WASP, QUAL2E, and PHOSMOD. He has additionally conducted modeling courses for more than 500 individuals in every region of the country and territories.

Jonathan Butcher
Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over seventeen years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He is the technical lead for projects to develop nutrient loading and response models for the Jordan Lake (NC) TMDL leads the development of multiple HSPF models for TMDL application over the entire Minnesota River watershed, and has been responsible for multiple mercury and fecal coliform TMDLs. Dr. Butcher's current research interests include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of many lake, river, and estuarine models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Thames Estuary in Connecticut. Dr. Butcher has been a lead author for several EPA Office of Water guidance documents, has published extensively in the refereed literature, and serves as a reviewer for several professional journals..

John Craig
Mr. Craig is a water resources specialist with more than 14 years of experience evaluating watershed and water quality problems and providing support for federal, state, and local policy issues. His areas of expertise include watershed management, Total Maximum Daily Load (TMDL) development and training; water quality assessment; and risk assessment. Currently projects include management of a nutrient criteria pilot study in Montana and North Dakota; management of a nutrient assessment for the watersheds of Lake Elsinore, CA; management and technical support for the development of nutrient and pathogen TMDLs for the Los Angeles River; and management and development of a watershed management plan and TMDL for Pineview Reservoir, Utah. Mr. Craig currently serves as the director of Tt's Fairfax Water Resources department and has been providing ongoing management and technical support for local, state, and federal water programs in the south and west.

Jeroen Gerritsen
Dr. Gerritsen has more than 25 years of experience in aquatic environmental sciences, including basic and applied research, teaching, environmental assessment, and project management. His technical abilities include statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, stream ecology, and plant-nutrient relationships. He has directed multidisciplinary investigations and has contributed technical expertise to impact assessment and regulatory review, effects of acidic deposition, and design and analysis of environmental monitoring programs. He has broad field experience in lakes of North America and Europe; in streams, wetlands, and estuaries of the continental United States; and in the North Atlantic ocean.

Kevin Kratt
Mr. Kratt has more than eight years of experience in water resources analysis for point and nonpoint source pollution in both urban and agricultural areas. This experience includes watershed modeling, water quality analysis, selection of water quality targets, and evaluation of best management practices (BMPs). He has also been extensively involved in the national and local evaluation of TMDL development activities and in various point and nonpoint source policy issues. Mr. Kratt has been supporting EPA and various state agencies on the TMDL and related programs since 1995. He has provided technical and programmatic support to all phases of the TMDL program, from guidance development, technical reviews, and TMDL development, to national training and facilitation. His support has included review of numerous TMDLs, technical oversight for more than a hundred TMDL development projects throughout the United States, development of new TMDL course materials, development of the first TMDL protocols and modeling compendium, and recommendations on various 303(d) listing issues. He has responded to numerous quick response requests for technical review and consultation. Mr. Kratt is familiar with most of the loading and receiving water quality models used for TMDL development, including their strengths and weaknesses for various applications.

Leslie Shoemaker
Dr. Shoemaker has 19 years of experience in water resources analysis for nonpoint source pollution in urban and agricultural areas, including watershed modeling, water quality analysis, mitigation evaluation, selection and design of best management practices (BMPs), and policy development. She is experienced in the management and coordination of large interdisciplinary projects involving public and agency participation. Dr. Shoemaker has state and federal governments on TMDL developed and related programs since 1991. She has provided technical direction and programmatic support for all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of over 79 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of nutrient and sediment criteria. She developed and provided TMDL training at over 30 locations over the past 3 years and is widely recognized as a national TMDL expert. She has responded to numerous quick response requests for technical review and consultation. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tt's Water Resources and TMDL Division which includes over 50 specialists in modeling, water quality assessment, and systems development throughout the

United States. Dr. Shoemaker is a Vice President with Tt's Fairfax, Virginia office and has overall authority for all staff presented in this proposal. She will provide overall management and direction and will ensure that appropriate and sufficient Tt resources are available for this project.

Barry Tonning
Mr. Tonning is a senior analyst specializing in environmental management, risk assessment and communication, public health issues, and technology transfer with extensive experience in policy development and program design for watershed assessment, planning, and management projects. Over the past 25 years he has directed and managed onsite wastewater and nonpoint source pollution assessment and control projects; environmental and natural resource policy research initiatives, solid waste planning and management programs; watershed training courses; the publication of environmental management guidance documents; and the development, coordination, and facilitation of public meetings, conferences, and workshops on a wide variety of environmental, public health, and natural resource topics.

2.8.3 Method of Providing Services and Quality Assurance

The California State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) are currently working with Tt staff on the development of *A Process for Addressing Impaired Waters in California,* which provides comprehensive guidance on state technical, regulatory, and legislative requirements associated with addressing impaired waters. In addition to the guidance, Tt is developing categorical guidance modules to address technical issues associated with the development of TMDLs for specific pollutants. A work plan for the pathogen module is shown below to provide DEQ an idea of how we typically approach the preparation of such documents. The module is intended to facilitate a greater understanding of expectations, which will result in improved coordination, consistency, and information exchange among RWQCBs when developing pathogen TMDLs.

Task 1. Determine Specific Scope of Categorical Module

The first task was to determine the specific scope of the categorical TMDL module for pathogens to ensure that it meets the needs of the SWRCB and RWQCBs. Tt reviewed previous material prepared by the Pathogen TMDL Workgroup and also met with the Workgroup to ensure a common understanding of the goals of the project. Examples of the types of questions that were answered during Task 1 included:

- Should the module focus on streams, lakes, coastal areas, or all of the above?
- How much detail is needed on modeling recommendations?
- How much detail is needed on data collection activities?
- Is there a preferred approach for pathogen TMDLs that should be included in the module?
- What are appropriate alternatives for allocating pathogen TMDLs?

Task 2. Research Key Issues

The purpose of the categorical TMDL module for pathogens was to address issues unique and especially important in California. Such issues included summer low flow conditions, effluent dominated streams, etc. Tt was already very familiar with each of these issues due to our previous work in California and throughout the country, but still researched previous studies for their possible inclusion in the module. Task 2 was therefore a detailed literature review to identify, assess, and summarize previous scientific studies important to the development of pathogen TMDLs in California.

Task 3. Prepare First Draft of Module

Task 3 involved the preparation of a first draft of the pathogen module and included a number of subtasks associated with each of the proposed sections of the document.
This section of the document summarized the water quality objectives of each of the nine regions that relate to pathogen impairments. Recommendations were made for how to determine impairment conditions and compare different types of data. This section built upon and summarized previous work to evaluate pathogen data within California.

Subtask 3.2 Data Compilation and Analysis

This section of the document discussed the compilation and analysis of data typically required during the development of a pathogen TMDL. It included recommendations for compiling and analyzing data for both the watershed (e.g., land use, topography, soils) and the receiving waterbody (e.g., hydrology, water chemistry, biological data). Tt developed a suite of customized spreadsheet tools in Microsoft Excel to assist with the analysis of pathogen water quality data.

Subtask 3.3 Technical Approach

This section of the document provided recommendations for selecting a technical approach with which to develop pathogen TMDLs. It included a discussion of the advantages and disadvantages of the various potential approaches, including modeling (e.g., HSPF, BATHTUB) and non-modeling (load duration curves, export coefficients) approaches. For each model or approach information was provided regarding how chemical, physical, and biological processes are addressed; the strengths/weaknesses of each approach; data needs; and where to go for more information. Tt also identified existing models or other tools that could be customized for the development of pathogen TMDLs in California.

Subtask 3.4 Source Assessment

This section of the document provided information on how to best estimate the impact of potential sources of pathogens on the receiving waterbody. Specific source categories that were addressed include: wastewater treatment plants, septic systems, agricultural operations, stormwater runoff, groundwater, and wildlife. The document contains information on how to estimate loads from each of these categories and where to go to get the information necessary to do so. Literature values specific to California were identified and included in the document.

Subtask 3.5 Alternatives Analysis

This section of the document described the process for calculating the TMDL and presented guidance on identifying and selecting appropriate allocations and management alternatives. It included a discussion of both the traditional approach (i.e., using a model to directly compare simulated concentrations to WQOs and to calculate corresponding loads) as well as alternative approaches (e.g., density-based allocations, allocations by river reach, reference system approach).

Subtask 3.6 Public Involvement/Public Meetings

This section of the document provided guidance on planning for and participating in public meetings associated with pathogen TMDL development. Information was provided on identifying stakeholders, coming up with an appropriate format for different types of meetings, answering questions, and employing effective strategies to motivate stakeholders to participate in the process.

Task 4. Address Comments and Submit Revised Draft of Module

During Task 4 Tt addressed comments made by the Pathogen TMDL Workgroup on the draft categorical module and submitted a revised draft for wider circulation.

Task 5. Submit Final Module

During Task 5 Tt addressed comments made on the revised nutrient categorical module and submitted a final version of the document. The project was completed on time and on budget.

2.8.4 Staff Qualifications

The table below summarizes the degree, discipline, years of professional experience, years of experience on similar projects, and professional rates for the personnel associated with this service category. Information regarding specialty training and professional registrations are included in each person's full resume, which are included as Appendix A. Detailed information on the project manager assigned to this service category, Ms. Jessica Koenig, is provided above.

Table 2-23. Staff qualifications for service category 3.5.23 (Preparation of Technical Manuals or Circulars).

Name	Highest Degree	Discipline	Natural Sciences Degree?	Years Experience[1]	Loaded Hourly Rate
Andrew Parker	M.E.	Civil/Environmental Engineering	Yes	8/8	141.74
Jonathan Butcher	Ph.D.	Environmental Engineering	Yes	17/17	143.77
John Craig	M.S.	Marine, Estuarine, and Environmental Science	Yes	14/14	154.51
Jeroen Gerritsen	Ph.D.	Ecology and Evolutionary Biology	Yes	25/25	140.70
Jessica Koenig	B.A.	Environmental Sciences	Yes	7/7	101.11
Kevin Kratt	M.S.	Water Resources	Yes	8/8	121.24
Leslie Shoemaker	Ph.D.	Agricultural Engineering	Yes	19/19	176.93
Barry Tonning	B.A.	Journalism	No	25/25	116.49